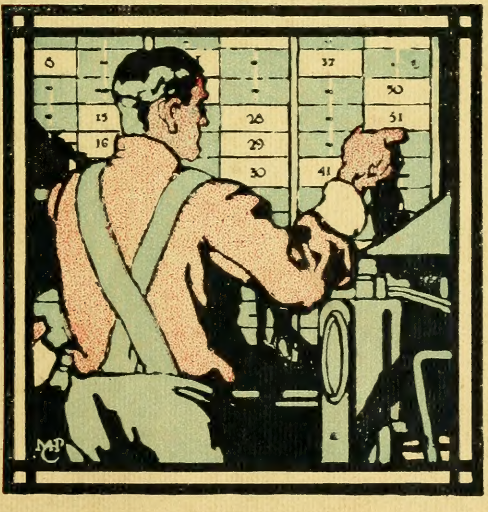
HOW SCIENTIFIC MANAGEMENT IS APPLIED

OUTPUT AND PROFIT INCREASING METHODS PUT TO USE IN LEADING FACTORIES



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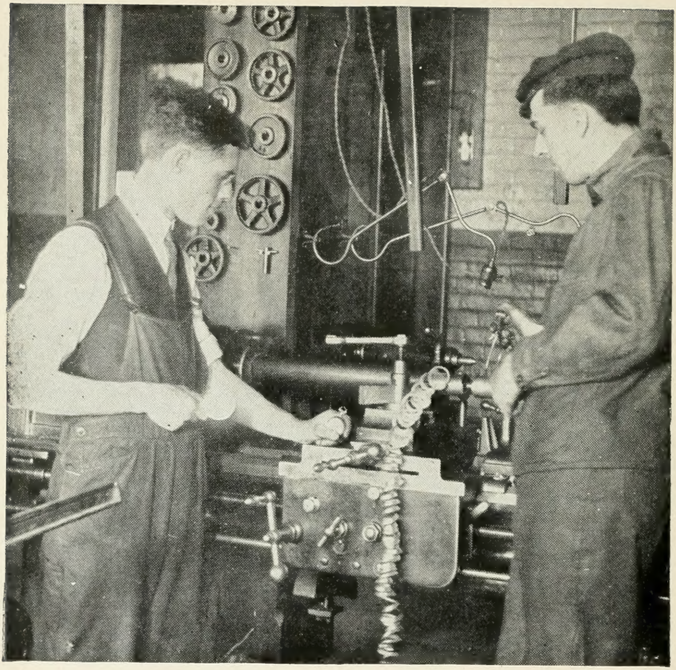
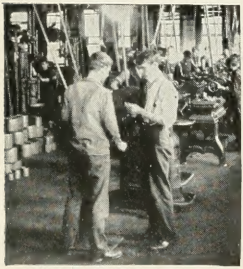
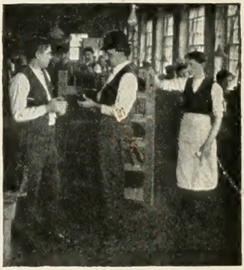




TIME STUDY OF JOBS



Stop-watch observations of individual operations are basic factors in the investigation which precedes the fixing of standards—the one right way. In the large picture, an investigator is timing a machine operation. In the small pictures, left and right, the investigators are studying the physical conditions affecting speed and quality

HOW SCIENTIFIC MANAGEMENT IS APPLIED

HOW THE ONE BEST WAY IS FOUND AND PUT INTO PRACTICE—HOW STANDARDS ARE SET—WHO CARRIES THEM INTO EFFECT—HOW MEN ARE TRAINED AND PAID—HOW PRODUCTION, WAGES AND PROFITS ARE INCREASED

BASED ON THE EXPERIENCE-TRIED METHODS USED IN EIGHT FACTORIES

SECOND REVISED EDITION

THE SYSTEM COMPANY
CHICAGO NEW YORK
A. W. SHAW COMPANY, LTD., LONDON
1911

SYSTEM "HOW-BOOKS"

How to Increase Your Sales

How to Systematize the Day's Work

How to Get More Out of Your Factory

How to Increase the Sales of the Store

How to Increase a Bank's Deposits

How to Sell Real Estate at a Profit

How to Sell More Fire Insurance

How to Sell More Life Insurance

How to Write Letters that Win

How Scientific Management is Applied

How to Sell Office Appliances and Supplies

Others in Preparation

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PLATE ILLUSTRATIONS

CHAPTER I

What Scientific Management Is

METHODS of doing business change. The red wagon of the tin-peddler has gone over the hill for the last time. The trolley takes the farmer's wife to the five and ten-cent store. The cobbler no longer sticks to his last, his work is done by machines and his former customers buy their shoes at one of a chain of retail stores.

Two worn phrases describe this gradual change in business—"specialization-of-work" and "mass-production." Machinery has taken the place of workmen. Work is duplicated by the thousand and "pushed through" in wholesale lots.

And with this gradual change in business has come as gradually but as surely a change in methods of handling work. One-man businesses are getting rarer. Instead, the authority of the one man has been divided into sections, each section has been given in charge of an individual who is responsible for carrying it out. As work has grown in bigness the more has it been subdivided into units.

Now this "line-organization" as it has been called, itself has been found inadequate. Men become too

specialized. The further the subdivision the greater the opportunities for leaks and wastes. And just as wastes in materials have been studied so now the wastes in management are being scrutinized. Machinery and men, materials and methods, money and markets are being considered from a new viewpoint, the "scientific."

Just as the scientist in a laboratory tears apart a complex substance, finds its different constituents, writes down the proportionate amount of each, then puts them together again—so the man who would practice "scientific" management analyzes his work. For scientific management simply is the laboratory method of studying work instead of the rule-of-thumb procedure. The scientific manager first analyzes with great accuracy the details of his problem, he tries to find the one best way, not by judgment alone, but by careful, thorough, painstaking investigation. Having found this better way the manager fixes tentative standards of work. Then he supplies an incentive for doing the work in the standard way.

To accomplish these results the scientific manager substitutes for the "old line organization" a "staff organization." Instead of dealing with mass-units by delegated authority, he separates the work into two big divisions, functions and operations.

The functional work, the designing and planning, the relating of each item of business to each other item is performed by staff-men. The doing of the work is carried out by the operating force.

Two men's names are intimately associated with this newer idea of management—F. W. Taylor and Harrington Emerson. Both have the same object—they differ principally in methods. Mr. Taylor's system of management is described in some detail in this book.

He subdivides the old organization and divides all work into two phases—planning and execution.

In Mr. Emerson's application of his twelve principles of efficiency, the old organization is kept, but a staff organization is added—specialists who plan and outline the more efficient principles for the older organization to carry out. Mr. Emerson's principles of efficiency are: Ideals; Common-sense and Judgment; Competent Counsel; Discipline; the Fair Deal; Accurate and Reliable Records; Planning and Dispatching; Standards and Schedules; Standard Conditions; Standard Operations; Written Standards of Instruction; Rewards for Efficiency.

When a manager analyzes any of these scientific principles of management in either the Taylor or Emerson school, he may find many of the detail methods of doing work not new. It is possible that he may have a better way of handling some detail. But the new *principles* should not be confused with *methods.* Scientific management is bigger and broader in its ideals than a system or method of doing work. Given the principles and a purpose to carry them out, any man may get results though his methods of applying the principles may vary.

To-day many a business is taking long strides toward the ideals of scientific management. For broadly, these are the steps which any business man may take, even if he is not in a position to secure the services of an expert—a man trained in the ways of scientific management and one who alone realizes the bigness and broadness of the principles with which he is dealing.

1. To separate from the "line organization" or to add to the line organization a staff officer or "staff organization."

2. To set up tentative standards of performance.

3. To correct these standards by working out scientifically the best methods of performance.

4. To determine the best inducement to the employee to attain these standards.

5. To equip the employee with clear, complete, and exact knowledge of the best and quickest way of doing the work.

This is not, perhaps, as Mr. Taylor or Mr. Emerson would designate them, but as they might be taken by a business man who, having studied the literature of scientific management, would apply its principles to an individual business problem.

For Mr. Taylor's studies have been of industrial workers. And the exact systems he has devised and installed have been applications of the principles or laws that he has discovered to industrial organization. They should be introduced, in their entirety, in no factory except under the direct supervision of Mr. Taylor or of men trained by him or trained directly under his influence.

Many a false prophet will come to the business men bringing only the shell of Mr. Taylor's methods and not the principles, just as when the first general introduction of business system brought in its trail heterogeneous assortments of cards, filing cabinets, and record sheets that involved endless clerical labor to operate and which in many cases constituted useless red tape.

For a period business men mistook the form for the substance; they believed that in the filling and filing of blanks they had "system," and ignored the real system of which these forms were merely the mechanical tools. The result was that this mechanical routine was either stripped of its non-essentials until it became a

serviceable implement or was discarded entirely for the old-fashioned inaccurate rule-of-thumb method.

A system is not a card or a filing cabinet; it is the right way of doing a thing. Similarly, Mr. Taylor's method of scientific management does not consist of forms or charts or of sets of rules and regulations. It is a big policy of establishing after scientific study and research a standard way of performing each industrial operation with the best possible expenditure of material, capital, and labor. The forms and rules are merely the machinery by which the policy is applied.

Back of the scientific principles and back of his particular method of applying them to actual workshop conditions, is this affirmation of the psychologists,—that all of us, employers and employees, have but a vague conception of what constitutes a full day's work for a first-class man.

Many of us confuse overwork with what is really underwork and it is only under a compelling incentive that we discover that like the runner we have a second wind.

And the problem is not merely to ascertain what is a full day's work for the workman but to ascertain what is a full day's work for the works manager, and for the office boy and the office manager, for the salesman and the sales manager, and how to induce the performance of that full day's work.

The principles of this science of business have only just begun to be formulated. But from a study of the principles of "scientific management" the business man can get a new business viewpoint—a new mental attitude toward his specific business problems.

That is important. For success or failure in business depends as much upon mental attitude as upon mental aptitude. And the mental attitude that prompts one

business man to make a scientific study of his own peculiar requirements and by experiment determine the most effective ways of getting the thing done—whether the task is carrying a pig of iron or selling a carload of canned corn—is the mental attitude that makes for business success.

If production costs have been high, the manager's method of attacking the problem in the past has been simply to try to lower wages or to add machinery. If selling costs have increased, he has tenaciously tried to increase selling prices. And in all of his movements he has usually been guided by accounting that was merely historic—not prophetic; but standards based on past performances—not carefully analyzing possible performances.

But a changed mental attitude suggests a new approach. If costs of production are high the business man will study the equipment that he already has. He will study workmen and ascertain scientifically just what is a full day's work for these workmen and what will help and will induce them to perform this full day's work. When selling expenses rise he will look first to the men who by words of mouth or by written words sell his products. And he will examine the standards against which these men are working and the exact methods that they use.

So the manager will gain, the workman will benefit, the customer will profit. For the reduced cost to make, the increase in wages, the reduction in prices come from the application of principles of efficiency—not by skimping material, but by finding how to use the least amount of the best—not by increasing the workman's pace, but by cutting his lost motions and applying his energy intelligently—not by increasing prices, but by increasing profit, by reducing costs.

CHAPTER II

The Five Steps To the One Best Way

IN EVERY business establishment it is possible to classify methods and knowledge sharply into two general divisions: first, those employed by the experts in the factory or office; second, those used by the ordinary routine worker. The latter class is almost certain to be many times larger than the first. Scientific management adopts the methods developed by the expert and makes them standard. Standardization consists in reducing to written rules the best methods, and prescribing them for general use.

But prescriptions are of no value unless they are used. So standardization amounts to nothing unless means are devised to put it into practice. Reduced to a broad table of classifications, scientific management resolves itself into the following program.

(A) Investigation by experts into every detail of office and shop, to ascertain where there is waste of any sort and how that waste may be minimized. In the factory or work room, labor is usually the chief concern of these investigators, who devote themselves to determining in detail how the waste of time and energy may be reduced. This often involves rearrangement of machinery or reversal of the sequence of operations, or

both, and the determination of the best methods for doing the work. These best methods are adopted as standards and the efficiency of the workroom gradually brought up to them.

(B) Following the establishment of standards, the development of a mechanism for carrying them into effect. Such a mechanism in the factory will enable the management to assign each day a specific task to each worker; to supply him with all the materials and appliances he needs to accomplish it; and to furnish him with a teacher able to interpret the instructions and show how they should be executed. In addition to this, the mechanism must incorporate means for getting each day accurate returns in detail as to how all instructions were carried out. This mechanism is called a "planning department."

(C) Finding and training workers to follow these standardized methods.

(D) Providing for adequate compensation of the worker when he attains the standard of efficiency.

(E) Developing, among workers who have attained the prescribed efficiency, a continual supply of skilled investigators and teachers to make the system self-perpetuating—to assure a continuance of scientific management.

The first step, *investigation*, offers a wide field and almost unlimited possibilities for increasing results if it is conducted according to scientific methods by trained men.

Neither the average manager nor the average worker knows off-hand the best method for doing any given piece of work. whether that work is at a machine, at a filing-case or back of a counter. The manager as a rule has made no study of the *time* a given operation should

take, of the time wasted by *poor or badly arranged equipment,* of the time lost by *inefficient* workmen, or of the delays caused by *bad service.* He has simply inherited or copied his methods.

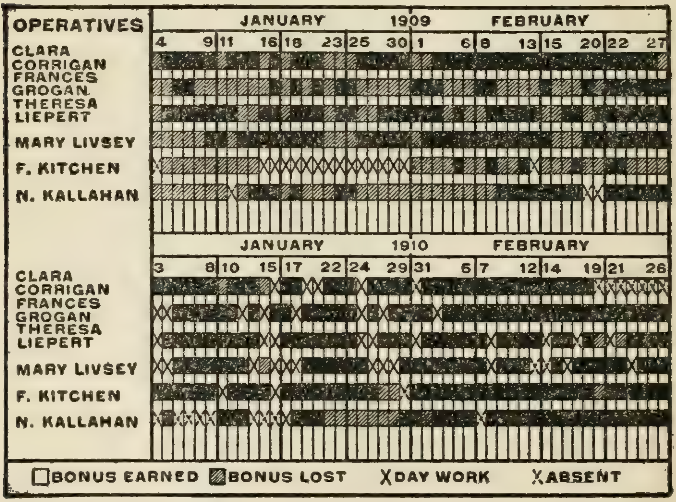
It is difficult to make the average manufacturer or merchant realize that loss or profit hinges on the small activities that go on around him. That the *management* has anything to do with such things has never occurred to him. These are affairs, he thinks, that should be looked after by the lower executive or superintendent. The latter, in turn, relegates to the department head or foreman such responsibilities as are customary. While the lesser executive likewise relinquishes to the clerk or mechanic much of the detail.

Now the scientific investigator steps in. There are many channels for investigation, and experts of divergent experience may be needed; but for illustration take this common example of labor investigation.

A trained investigator with a stop-watch stood at a loom in a cotton mill and studied and timed all the motions of the weaver, recording each: how he stopped his loom, how he started it, how he removed the empty bobbin from the shuttle and put in a new one, how he tied the knot, and so on. The weaver chosen was the most skilful in the mill. Then every condition surrounding the loom was studied with equal minuteness. Records were made of the time lost because of "no filling" or other causes, and every obstacle in the way of continuous work was eliminated. The result was that the looms and the workers were enabled to turn out a largely increased product, sometimes double the former average per loom, of the mill.

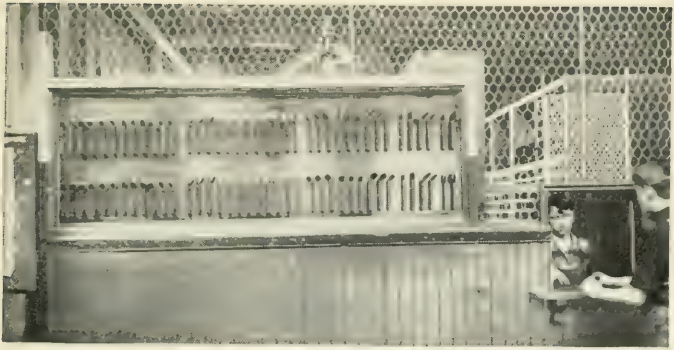
In another instance, an investigator studied the simple work of a shoveler. Every motion was recorded by

means of the stop-watch, while the shape, size, and weight of the shovel itself were observed with reference to different sorts of material to be shoveled. Experiments were made to determine the necessary periods of rest between motions. The result showed that the shovelers could readily move three times the quantity they actually were moving.



This chart shows the bonus record of workers in a folding 'room; solid black means bonus earned, ruled squares mean bonus lost. The improvement in the workers' efficiency, shown by the increases in bonus-earning in 1910 over 1909, is strikingly apparent

Going up higher in the scale of *investigation,* take the case of a certain dyeing establishment. One branch of the inquiry concerned the proper use of dyestuffs. There had been no standardized method that reached all the details and recorded them, but one was evolved. Complicated processes are composed of simple processes, and study will effect savings, as it did here in dyeing material. Investigation sometimes shows that the proc-



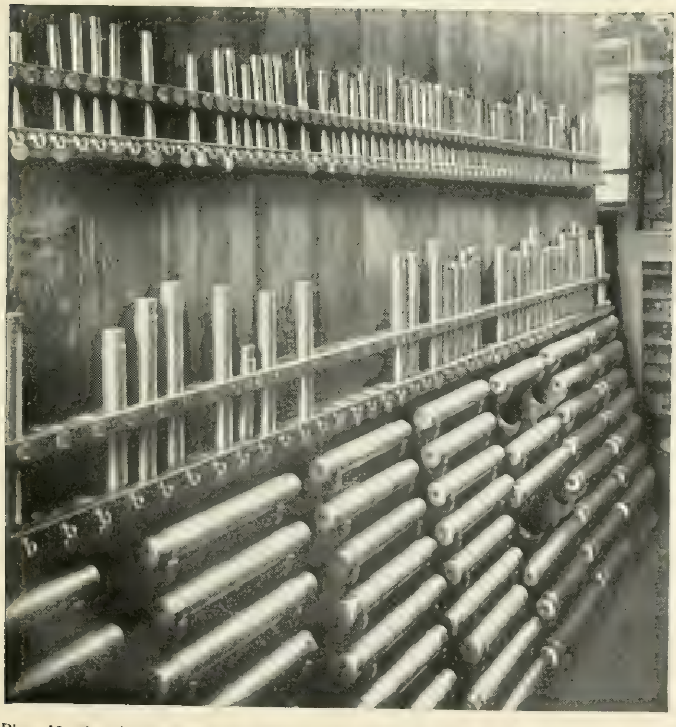


Plate II: Standardized sample tools and methods of storage at the Link Belt factories

Plate III: The planning room where every order accepted is analyzed, divided into separate jobs and assigned to the machines best adapted to its performance. Here work tickets or instruction cards are made out for each individual process involved, requisitions on raw and finished stock made out, time-study results tabulated, standards fixed, rates set and costs computed

esses are satisfactory; that the maintenance of maximum normal speed of operation is the chief requirement.

Because it is difficult to keep an exact record of what each worker does, or to gauge results, the employer usually keeps no individual records at all. He has no way of distinguishing his men except through the judgment or favoritism of those immediately in charge. So, like the shop worker whose individual record is not kept, the unusually capable clerk soon runs down in efficiency to the commonplace level.

Investigation at a bleachery determined the need for certain automatic machinery, and this was invented. Investigation in a steel plant resulted in high-speed steel. Investigation into bricklaying disclosed astonishing possibilities. Instances might be multiplied to show that *investigation* has been the precursor of decreased costs and multiplied profits. One discovery leads to another.

Tagging all time- and labor-*wastes* in one operation or department and finding in each case the right *way of doing things,* the second step in scientific management is to establish the improved method as *standard.*

Take, for example, a machine shop that was badly laid out. This shop was doing a great variety of work. Here the investigators determined that the machines should be arranged so that any given foreman might supervise the work in which he was especially skilled. The machines were arranged in groups, the large lathes in one, the small lathes in another, the planers in another. For determining the best way to do the work on each class of machines a slide-rule was devised after long and patient experiment. In another shop machinery was rearranged so as to bring together allied operations and reduce the time of transportation.

The process of standardization is usually very slow. The patience needed for this sort of effort is illustrated in the experience of a certain mill. Here a record of over one hundred workers shows that standardization is bringing an increase of output of over one hundred per cent, and that unit costs are only sixty per cent of what they were formerly. To accomplish these results, however, many months of detail inquiry and progressive instruction were necessary.

Standardizing a business, it should be remembered, does not necessarily mean enlarging it. On the contrary, it commonly has the effect of reducing its visible dimensions, while increasing its ability to make money. It means equipping it with facilities for doing things the best and quickest way. It is simply a synthesis of results obtained by investigating separately each element and unit. To express it in another way, it is the reduction of *expert* work by making it *routine,* and the application of the expert method to every routine operation or task.

Standardization is a process best performed when the business is not already on its last legs. Prosperous times often enable a badly managed business to get ahead, while a sudden curtailment of orders, or sharper competition, would show up its hopelessly high expenses and costs.

Into this phase of standardization (Classification B) the *planning department* enters very conspicuously. The highest type of management is the one which uses all the available knowledge of its organization to *plan* its work, and to make sure that the work is done in accordance with those plans. The ordinary business house requires its goods to be up to specifications, but follows only loose specifications in dictating the operations that

go into those goods, either directly, as in labor, or indirectly, as in general expenses. The result is high costs, for every minute you lose means outlay, every questionable method piles up expense. So the scientific factory manager counts the motions and figures, the time needed, in hours and hundredths of an hour. He does not buy merely the *time* of his workers, but buys the number of specific motions he wants them to make. He is enabled to specify these motions through the knowledge stored in the planning department.

Buying human service, whether of laborer, skilled worker, clerk, or salesman, is the hardest problem the manufacturer or merchant has to face. Men prefer to sell their time rather than their labor and to perform in that time whatever quantity and quality of work they consider proper. Usually the manager buys service with loose specifications, and is unable to ascertain what he is getting. The great error in buying labor is to attempt to standardize the method of payment without adequately studying and standardizing the task.

The expert manager, therefore, analyzes everything that is done *before it is done*, and sets a task wherever possible. In the scheme of scientific management the planning department analyzes all work to be done and determines the expert manner of doing it. In the standardized office the methods and equipment are prescribed in minute detail, and in many of the routine office operations it is possible to set a task with time specifications. In the workroom the planning department specifies labor just as an engineer would specify detail measurements in the purchase of machinery.

The planning department handles the routine by which the activities of the scientifically managed establishment are carried out. It sets and maintains a uni-

form "balance of stores," so that supplies and materials will neither run short nor exceed the necessary quantity. It makes time-studies, through its investigators, of all operations done by hand, including the setting of work in machines, and similar time-studies of all machine operations. It determines the best and shortest way of performing each operation or process, then sets and maintains the standards. It determines the amount of work ahead in each department.

It supplies exact information as to the time and cost of any work about which inquiry is made. It collects, distributes, and records all items of cost, and conducts the pay department. It is the center of all the indexed information of the plant. It applies some system of mnemonic symbols to machines, operations, materials, parts and charges in order to reduce clerical work and the actual writing required of workmen. In short, it maintains, directs and drives the mechanism of scientific management.

Passing on to the third step, the manager is confronted with the difficult task of finding and training capable workers, without whom all the investigations and standardization would avail but little. The original hiring of these men must be done with special reference to the needs of the system, and after they have been taken on, a fixed policy must be followed in handling them. This, indeed, is the second great problem in scientific management. Having learned *how* things ought to be done, there follows the proposition of *doing* them.

The problem reaches up into executive realms, for in an "efficiency" organization each individual has responsibilities which directly affect other individuals. The system is no respecter of persons. The executive who wants a workman to do his duty must see that the

task is properly set and that the *means* of accomplishing it are available.

Every loss of bonus is investigated, since failure shows that the plans have not been carried out. There is at all times a strong pressure on each worker, high or low, to do his share of the common task. As no bonus is paid unless the work is up to standard, both in quantity and quality, the men are quick to resent anybody's failure to perform an operation which affects their work, or any neglect to supply them with the necessary material or tools. In one instance a weaver, notoriously slow and indifferent under the old system, raised a great row on a certain occasion because he was not properly served under the new system. It had taken weeks to train that man and change his mental attitude towards his work, but once this was accomplished he became thoroughly efficient. In office and workroom you will find that the majority of persons are doing things in the wrong way because they have never been instructed in the right method.

The primary element in getting men up to standard efficiency, then, is *teaching*. A long course of training is often necessary before even one man in the establishment will accomplish a given task regularly. The most skilful workman is seldom able to perform the task set, at the first trial. So an instructor must be at hand who is willing and competent to teach the workers, individually, how to follow the planning department's directions. It happens frequently in shops where efficiency methods are in force, that a workman, finding himself unable to accomplish his task in the standard time, will ask the instructor to time his detail motions with a stop-watch so that he may discover where he is falling behind.

Under scientific management, no worker is ever asked to perform an operation without careful preliminary coaching. He is given a reasonable time to unlearn his accustomed method and master the right way. These first efforts are often discouraging, to the management as well as the worker, but experience in many plants has demonstrated the uniform possibility of teaching men and women to work at normal maximum efficiency without greater effort than was required to work at half efficiency. It is a most important fact that *the swiftest operators almost always do the best work, if they are working under instructions.*

Since every part or product must pass inspection before the bonus is alowed, quality can never be slighted. Concentrated attention, therefore, is necessary. It is a psychological truth that a task in which we are interested is performed with less fatigue than one we must force ourselves to do. Far from setting up conditions and stresses detrimental to health, as some seem to fear, the introduction of scientific management invariably brings about a betterment.

First of all, there is no driving—no forcing of workers to learn the swifter, more economical way until they satisfy themselves that it is to their advantage. The first weaver put on task work in a New Jersey cotton mill, for instance, refused to attempt the task. He was not discharged, but was simply allowed to continue in the old way. Two others were willing, but they failed for several days, though among the most skilful weavers in the mill. Then their brains and hands forgot the old, clumsy methods and fell into the rhythm of the new. Thereafter the tasks were easily accomplished.

Increases such as this are not due wholly to standardized methods and trained skill of workers. Improvement

in quality and quantity comes also from the maintenance of equipment at the highest pitch of efficiency. Work done with such machinery and according to prescribed methods of operation is certain to couple uniform quality and speed. Work done with poor equipment and according to varying judgment of individuals is certain to accomplish the opposite result.

DETAILED INSTRUCTIONS	TOOL USED	DEPTH OF CUT IN INCHES	FEED IN INCHES	SPINDLE R. P. M.	SPEED IN FEET PER MIN	MIN ALLOWED
1. SET UP AND CLAMP ROD						5.0
2. SET TOOL						1.0
3. ROUGH TURN BODY AND CROSS HEAD FIT	PRSE	1-4	3-32	44	40	10.5
4. CHANGE AND SET TOOL						1.5
5. ROUGH TURN CROSS HEADFIT AND COLLAR		1-4	1-8		40	3.0
6. REVERSE AND RECLAMP ROD						2.5
7. ROUGH TURN PISTON CLEARANCE BOSS		1-4	3-32		48	7.0
8. REMOVE						2.5
			TOTAL MINUTES			33.0
F. H. ANGUS SHOPS C. P. R.			TOTAL HOURS PER PIECE			0.55

An example of an instruction card made out in the planning department on the basis of standardized processes, directing the workman how he shall finish a piston rod

Scientific management recognizes the fact that *training* workers is as much a function of management, as is the providing of suitable materials and machinery. Increase in efficiency is essentially the problem of the manager. The lesser executive often has had no training in management and has no capacity for it. Almost invariably, he is overworked. Yet the "front office" seldom has time to inquire into his troubles, and usually, when conditions become unbearable a new foreman is appointed, thus perpetuating the situation and making matters worse.

Classification D brings up the question of compensating the worker who has attained efficiency, and compensating, as well, all those who have served him and enabled him to maintain the standard efficiency. It was a thorough study of this problem that led the writer first to adopt the *task and bonus* method, which has since come into general use where scientific management is in force.

Any scheme of management must be beneficial alike to employer and employee, or it will fail. A workman will not follow instructions unless he is convinced that obedience will be to his advantage. You cannot force him to do it, and usually, in the beginning, he is quite hard to convince. Once you have induced him to try, and have trained him to accomplish his task, you must keep absolute faith with him. You must maintain the strict standards of equipment and service by which he is enabled to do the prescribed task. Having set a task, you must not increase it unless at the same time you improve the method of doing it. If you find you have made a mistake in favor of the workman you must abide by the error, until an opportunity offers to improve the method of performance.

Time-rates must never be lowered, unless you have shortened the work proportionately. The cutting of rates is one of the great evils of the ordinary piece-rate system. When men develop efficiency, the rate is usually cut. You cannot continue to develop efficiency anywhere unless you give the workman and the executive a fair share in the reward. The *task and bonus* method, in its various adaptations, will do much to solve labor problems, for wherever it is in use labor disputes have been eliminated.

The object of labor unions is the advancement of their members, but they fall short of their purpose be-

cause they look to the advancement of their members alone. Any real solution of the labor problem must offer advantages both to the employer and employee. The *task and bonus* fills this specification, and while it does not in any way antagonize the objects of the unions, it adds the feature which they fail to supply.

To secure the best results, the reward for the accomplishment of a task—which varies from twenty to one hundred per cent, according to the difficulty or disagreeable nature of the prescribed task—must apply not only to the actual workman, but to the teacher who aids in bringing up his efficiency. For every workman who attains efficiency, a specified bonus is allowed the teacher, and an extra bonus is given the latter when all his workmen attain the efficiency standard.

The final classification, E, deals with a question of supreme importance: the perpetuation of the system of scientific management. In the ordinary scheme of administration, the maintenance of efficiency is the task of the higher officers. When good executives grow old or leave they are likely to be replaced by others not so competent to handle men and situations, who follow their individual judgments and thus injure the whole fabric of organization. Under scientific mangement, on the contrary, the details of operation are not left to individual judgment, and the coming or going of higher executives does not affect the methods governing processes and operations.

The system is continually developing its own staff material, which comes along automatically. It is from the trained workmen that we get a supply of investigators and teachers and occasionally a capable task-setter. From the task-setters come the foremen.

CHAPTER III

Setting Standards With a Stop Watch

FIRST step in the application of the principles of scientific management is *investigation.* Coupled with it as was shown in the last chapter, is *standardization. Detail investigation* of methods, processes, equipment, materials, labor and physical conditions, will discover wastes and losses and will indicate how to cut them out. Hand in hand with *investigation* is *standardization,* the development of the right way or economical practice and its fixing as the shop standard.

No business man will quarrel with the first process—investigation. To get at the facts which govern costs and control the quality and quantity of output is recognized as fundamental. Success in manufacturing or in selling is normally based on special knowledge gained by conscious or unconscious study of primary, detail processes.

One manufacturer, graduating from bench of foremanship, is able to apply his store of short-cuts and economies to his new venture; is able to detect any glaring waste or lost motion in operations hitherto unfamiliar; is able to teach his mechanics the better, the

cost-reducing way. Another maker, coming from the selling field, balances his rival's production strength by knowledge of selling methods and ability to develop a marketing plan which lops off useless expense and plots a bee-line to the consumer's appetite or need.

Each forges ahead because of technical mastery in a limited field. Each in this field is a primitive "efficiency engineer," questioning methods wherever experience gives him a critical viewpoint, finding a better way frequently by patient rule-of-thumb experiment. Outside his zone of experience, however, he usually accepts tradition or the general practice as his law.

This stubborn faith in accustomed standards appears the moment detail investigation begins. As an illustration of the methods pursued and the attitude often encountered in shop executives, take the earliest studies made of operations in the Philadelphia plant of the Link-Belt Company.

The foreman of the room in which gears were cut insisted that his men were working at the fastest pace compatible with perfect product. His cost sheet showed that an order for 149 wheels of a certain type required 322.4 machine hours to cut the gears and cost in day wages $37.50. There was no visible loafing and no apparent wastes. Yet when a trained time-study man completed a series of stop-watch observations of the motions involved in setting the parts, starting the tool and finishing the operation, the revelations were astonishing.

For the test he selected the most expert gear-cutter in the shop, explained his purpose and secured his consent to the timing. Then he reduced gear-cutting to its unit motions and again and again as the operation was repeated he recorded the time consumed in

SHOVELING EARTH IN AVERAGE CONTRACT WORK

EARTH PREVIOUSLY LOOSENED.—VOLUMES ARE BASED ON MEASUREMENT IN CUT.

MATERIAL	THROW		LENGTH OF WALK	ACTUAL CONTINUOUS WORK WITH NO ALLOWANCE FOR REST OR OTHER STOPS.										PER CENT OF REST			
	VERTI-CAL	HORI-ZONTAL		TIME TO FILL SHOVEL	TIME TO THROW SHOVEL FUL	TIME WALK-ING WITH LOAD	TIME OF BACK WALK	TOTAL TIME OF COM-PLETE OPER-ATION	VOLUME OF SHOVEL-FUL	WEIGHT OF SHOVEL-FUL	NO. SHOVEL-FULS PER MINUTE	NO. CUBIC YARDS PER HOUR	NO. POUNDS PER HOUR		NO. SHOVEL-FULS PER MINUTE	NO. CUBIC YARDS PER HOUR	NO. LBS. PER HOUR
	FEET	FEET	FEET	MIN.	MIN	MIN.	MIN.	MIN.	CU. FEET	LBS.	SHOV-ELS	CU. YDS	LBS.	P. C.	SHOV-ELS	YARDS	LBS.
SAND OR SANDY LOAM	4	5	.....	0,073	0,031	.....	.....	0,104	0,16	16	9,6	3,4	9,230	30	7,4	2,6	7,100
	6	5	.....	0,073	0,043	.....	.....	0,116	0,14	14	8,6	2,7	7,250	30	6,6	2,0	5,580
	8	5	.....	0,073	0,056	.....	.....	0,129	0,11	11	7,8	1,9	5,120	30	6,0	1,4	3,940
	4	7½	.....	0,073	0,043	.....	.....	0,116	0,14	14	8,6	2,7	7,250	30	6,6	2,1	5,580
	6	7½	.....	0,073	0,056	.....	.....	0,129	0,12	12	7,8	2,1	5,590	30	6,0	1,6	4,300
	4	10	.....	0,073	0,058	.....	.....	0,131	0,13	13	7,6	2,2	5,960	30	5,9	1,7	4,580
	6	10	.....	0,073	0,076	.....	.....	0,149	0,11	11	6,7	1,6	4,440	30	5,2	1,3	3,420
	.....	.....	20	0,073	0,020	0,080	0,080	0,253	0,20	20,0	4,0	1,8	4,750	5	3,8	1,7	4,520
	.....	.....	30	0,073	0,020	0,120	0,120	0,333	0,20	20,0	3,0	1,3	3,600	5	2,9	1,3	3,430
LOAM, GRAVELLY	4	5	.....	0,092	0,031	.....	.....	0,123	0,14	15,8	8,1	2,5	7,700	30	6,2	2,0	5,920
	6	5	.....	0,092	0,043	.....	.....	0,135	0,13	14,7	7,4	2,1	6,520	30	5,7	1,6	5,015
	8	5	.....	0,092	0,056	.....	.....	0,148	0,10	11,3	6,8	1,5	4,580	30	5,2	1,2	3,530
	4	7½	.....	0,092	0,043	.....	.....	0,135	0,13	14,7	7,4	2,1	6,510	30	5,7	1,6	5,010
	6	7½	.....	0,092	0,056	.....	.....	0,148	0,11	12,4	6,8	1,6	5,030	30	5,2	1,3	3,970
	4	10	.....	0,092	0,058	.....	.....	0,150	0,12	13,6	6,7	1,8	5,440	30	5,1	1,4	4,180
	6	10	.....	0,092	0,076	.....	.....	0,168	0,10	11,3	6,0	1,3	4,030	30	4,6	1,0	3,100
	.....	.....	20	0,092	0,020	0,080	0,080	0,272	0,19	21,5	3,7	1,6	4,750	5	3,5	1,5	4,520
	.....	.....	30	0,092	0,020	0,120	0,120	0,352	0,19	21,5	2,8	1,2	3,670	5	2,7	1,1	3,490

This record from F. W. Taylor's "Shop Management" is worked out from individual motion studies and covers every class of contract work. Notice that every influencing factor is carefully specified. The detail and care with which each analysis is made is a good example of the thoroughness which is essential if "scientific" management is applied

hundredths of an hour. Certain of these units showed wide variations; noting these, the observer analyzed the causes.

Whatever the reason, it was marked down for elimination just as the happy, economical method of doing anything was verified and put down as a standard.

After scores of gears had been cut thus, experiments were begun to find the shortest, easiest or most effective way of getting each result. The rough castings were piled so that the workman could take each up instantly; more rigid inspection, working back on the foundry, cut out the casting imperfections which caused delays; the sequence of processes was changed and the size, quality and speed of the cutting tool were varied until the most effective combination was found.

Then patiently the investigator worked out the sum of the most efficient unit methods, averaged the time for each, fixed standard sequences and times, and asked for another order of 149 gear wheels. Imagine the bewilderment of foreman and shop, and the delight of the "front office" when the 322.4 hour job was completed in 188.1 machine hours with a labor cost of only $20.09. Time saved forty-two per cent, wages saved forty-seven per cent.

Neither saving, remember, was effected by speeding up the man, in the ordinary meaning of the phrase. Instead, the methods of science and mathematics were brought to bear on his task, to make it easier, to cut out false motions and unnecessary expenditure of energy, to correct errors of judgment and adjust physical and mechanical conditions. When you chop a scantling with a dull hatchet the waste in time and energy is due to poor equipment. If in addition you flourish the hatchet before each stroke you have a typical false

motion such as an intelligent inquiry detects and taboos.

Investigation and standardization, in the Link-Belt organization, was extended to every detail process and production factor in its three factories at Philadelphia, Chicago and Indianapolis. In some specific cases the savings were nothing short of revolutionary: on one operation requiring two hours to complete, the investigator found that by rearranging routes and making changes in the machine and methods, the time needed could be cut to fifteen minutes.

The foreman hooted the proposal, and at first seemed to have the better of the argument. A good mechanic was put at the task, and saved only six minutes over the old way. Within a few weeks, however, when he had unlearned his old methods and accustomed himself to the short cuts taught him he reached and maintained the investigator's standard of fifteen minutes. His own wages were increased sixteen per cent on the bonus plan. On another operation the time was cut from 4.4 hours to 1.5 hours, on a third from 2.4 hours to .45 of an hour.

In these and indeed in almost all other instances, the workmen required only two or three weeks of instruction and encouragement to attain the predetermined standard.

This does not mean, however, that the time-study, preparation of schedules and instruction can all be crowded into a few weeks. Emphatically, no. The reduction of time outlay on one operation from two hours to fifteen minutes may require a year of investigation and readjustment of routing, methods, tools, men and materials. But when all this preliminary work has been done, when the *right way* has been worked

out and all its factors determined, it is possible sometimes to work a swift transformation.

In the works of the Bullard Machine Tool Company, at Bridgeport, Connecticut, for instance, the primary or producing departments under the old regime were always behind the erecting rooms. When therefore, a system of unit times was prepared for all operations from raw stock handling up to shipping, and announced to the shops, there was general skepticism on the part of the workmen. To give the doubters a convincing lesson, Mr. Bullard made out a schedule of delivery dates for a specific group of machines just about to be manufactured. He even named, weeks in advance, the day and hour on which each was to be completed, No. 1 for Dec. 20 at 2 p. m., No. 2 for Dec. 21 at 5 p. m., and so on through the order.

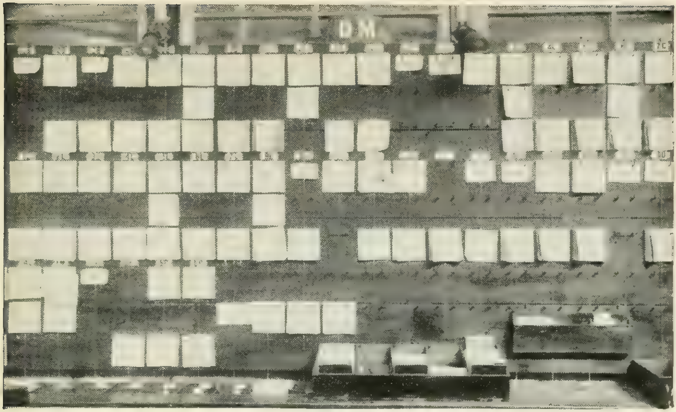
Mechanics and erectors were amazed at the innovation: accustomed to the hit-or-miss schedules of former years, Mr. Bullard's program seemed impossible. But that program was the sum of hundreds of unit operations which had been analyzed, standardized and for which unit times had been determined. The chief task was one of dispatching, of holding individual workmen and departments up to the schedules, and because the purpose of impressing the new system upon the organization justified the care and watchfulness demanded, the thing was carried out. Every machine was completed on time; and the finishing of the last one on the prescribed minute was made the occasion of a celebration which further fixed the fact in the workmen's consciousness.

Never since then has the Bullard force questioned the schedules prepared for them or the wisdom of the dispatching system. Remarkable results have been at-

tained here. When the system was introduced the average efficiency of piece-workers was sixty-seven per cent of what might have been accomplished. Last month the efficiency sheet showed a general average of ninety-one. In the erecting department, the efficiency has gone to 109, in the turning department to 107, and in the boring department to 103. An average efficiency of eighty-five is required of each man, or he is discharged. Wages have risen twenty per cent.

A striking feature is the entire lack of friction. For it is the theory and practice of this form of management first to lay out and pave the road, then furnish vehicles that run as smoothly as a ball-bearing machine. Equipment must be brought as near perfection as possible, and surrounded with *planning* and *serving* facilities. This is a cardinal principle: the owner of the business serves his workers, instead of commanding them. The old-style military rule is abolished. No man is dependent on the whim of a foreman. In some plants so managed even the foreman himself is banished, his place being supplied by instructors who have no authority to change any method or standard, and whose function is merely to assist the men or women to earn more money by doing things in the prescribed way. If the task is accomplished, the worker gets his bonus; if he fails, even by a minute, he loses his bonus but still gets the usual hour rate. And if all the workers under a given instructor accomplish their tasks, the instructor receives a special bonus.

So, when an employer puts a man at a machine or at a desk under this system, he, the employer, instantly becomes his servant in the sense that he plans for him, supplies him with tools, material, drawing, education. He asks only that the worker shall avail himself of all these advantages, and takes his pay in increased output



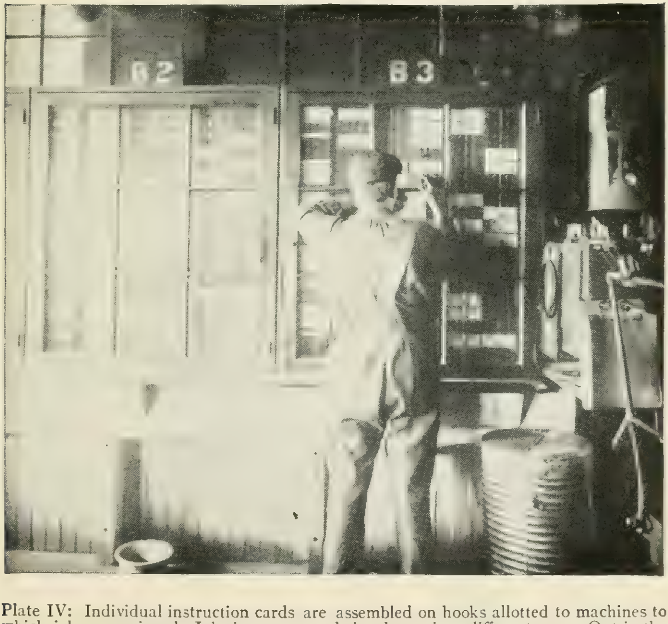
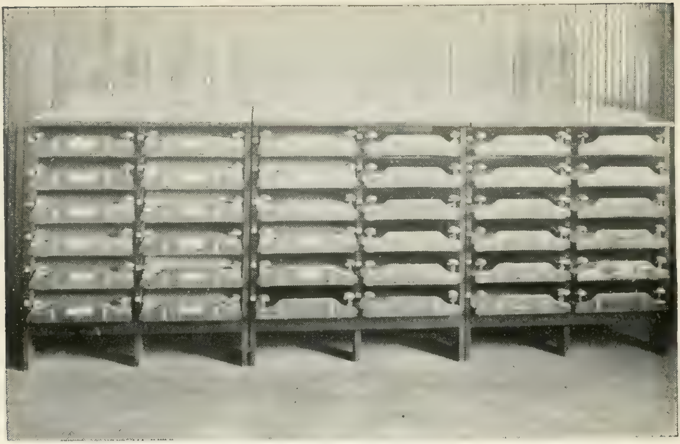


Plate IV: Individual instruction cards are assembled on hooks allotted to machines to which jobs are assigned. Jobs in process and ahead are given different rows. Out in the shops may be a board like that in lower cut where the gang boss can keep work tickets



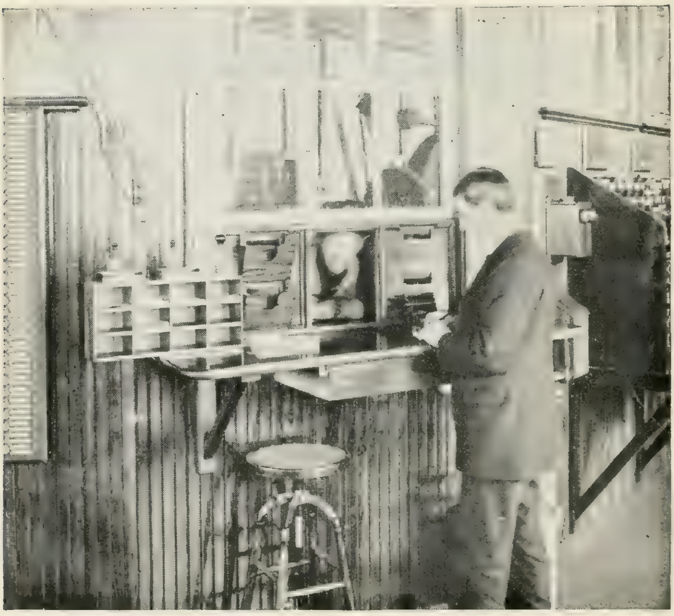


Plate V: Above are the route sheet files at the Tabor Manufacturing Company's factory. They are located at the right of the man in the lower picture

THE MIDVALE STEEL CO.

MACHINE SHOP, ______________ 19__

ESTIMATES FOR WORK ON LATHES

OPERATIONS CONNECTED WITH PREPARING TO MACHINE WORK ON LATHES AND WITH REMOVING WORK TO FLOOR AFTER IT HAS BEEN MACHINED

OPERATIONS	TIME IN MINUTES	
PUTTING CHAIN ON, WORK ON FLOOR,		
" " WORK ON CENTRES,		
TAKING OFF CHAIN, WORK ON FLOOR,		
" " WORK ON CENTRES,		
PUTTING ON CARRIER,		
TAKING OFF "		
LIFTING WORK TO SHEARS,		
GETTING WORK ON CENTRES		
LIFTING W'K FROM CENTRES TO FLOOR,		
TURNING WORK, END FOR END,		
ADJUSTING SODA WATER,		
STAMPING,		
CENTRE-PUNCHING,		
TRYING TRUENESS WITH CHALK,		
" WITH CALLIPERS,		
" WITH GAUGE,		
PUTTING IN MANDREL,		
TAKING OUT "		
PUTTING IN PLUG CENTRES,		
TAKING OUT "		
PUTTING IN FALSE CENTRES,		
TAKING OUT "		
PUTTING ON SPIDERS,		
TAKING OFF "		
PUTTING ON FOLLOW REST,		
TAKING OFF "		
PUTTING ON FACE PLATE,		
TAKING OFF "		
PUTTING ON CHUCK,		
TAKING OFF "		
LAYING OUT,		
CHANGING TOOLS,		
PUTTING IN PACKING,		
CUT TO CUT,		
LEARNING WHAT IS TO BE DONE,		
CONSIDERING HOW TO CLAMP,		
OILING UP,		
CLEANING MACHINE,		
CHANGING TIME NOTES,		
CHANGING TOOLS AT TOOL ROOM,		
SHIFTING WORK,		
PUTTING ON FORMER,		
TAKING OFF "		
ADJUSTING FEED,		
" SPEED,		
" POPPET HEAD,		
" SCREW CUTTING GEAR,		
SIGNED, TOTAL,		

NAME, ______________

SKETCH, __________ NUMBER, __________

ORDER, __________ WEIGHT, __________

METAL, __________ HEAT NO. __________

TENSILE STRENGTH, __________ CHEM. COMP. __________

PER CENT. OF STRETCH, __________

HARDNESS, CLASS __________

OPERATIONS CONNECTED WITH MACHINING WORK ON LATHES

OPERATIONS	SPEED,	FEED,	CUT	TOOL	INCHES	MINUTES
TURNING FEED IN,						
" "						
" HAND FEED,						
" "						
BORING FEED IN						
" "						
" HAND FEED,						
" "						
STARTING CUT,						
" "						
FINISHING CUT,						
" "						
FILLET,						
"						
"						
COLLAR,						
"						
FACING,						
"						
SLICING,						
"						
"						
NICKING,						
"						
CENTRING,						
"						
FILING,						
"						
USING EMERY CLOTH,						
" "						
TOTAL,						

MACHINING — TWO HEADS USED.
" — ONE HEAD USED,
HAND WORK,
ADDITIONAL ALLOWANCE,

TOTAL TIME,
HIGH RATE,
LOW RATE,

REMARKS,

TIME ACTUALLY TAKEN,

On the Taylor instruction card at the left the operations are divided into two classes. A minute analysis is made of each job. Time-study of operations is only one function of investigation. This is the most fruitful field for economies, perhaps, but the search for wastes, energy losses and other handicaps, including equipment, materials, supplies lighting, shop service, and every other detail which affects production adversely or advantageously

and higher quality. A fair measure of what has been accomplished is afforded by the statement of James

Mapes Dodge, chairman of the Link-Belt Company, that certain departments of his reorganized plant, running at sixty per cent capacity, now produce as much as under the old system running full time.

Time-study of operations is only one function of investigation. This is the most fruitful field for economies, perhaps, but the search for wastes, energy losses and other handicaps, includes equipment, materials, supplies, lighting, shop service, and every other detail which affects production adversely or advantageously. The care of belts; the quality, character, size, shape and condition of cutting tools; the rates of speed and feed at which machine tools do their best on various materials and parts, the storage, up-keep and issuing of tools, jigs, templets, and so on; the system governing the supplying of materials or unfurnished parts to workmen—all these come under scrutiny and must be standardized before the results of time study can be properly applied.

This technical phase of the investigation work was emphasized in the recent experience of a western pulp mill. Built to manufacture twelve tons a day, the output could never be brought up to that figure and the business proved unprofitable. As a last resort an efficiency engineer was engaged. He made an analytical study of every element, took up the chemistry of the processes, introduced new acids to combat conditions, made changes which cut the time required for cooking by one-half, and greatly reduced the time and labor spent in washing. Every process was shortened and speeded up, every operation put on schedule. At the end of the third year, the mill was producing, not the twelve tons for which it was intended, but thirty-six tons daily.

Frequently the changes required seem so simple it is hard to conceive their escaping notice for any length of time. In a large bleaching and dyeing establishment at Wilmington, Delaware, over-time in the folding-rooms was not enough to avoid congestion and delays in filling orders. An investigation was begun to discover and eliminate the obstacles to output.

Stop-watch study of the detail operations brought important time losses to the light immediately. Folding cloth, for instance, had developed almost as many methods as there were individuals. The investigator, indeed, soon learned that few of the girls observed the same sequence of motions all the time. But all took two steps to the right to secure their cloth, returned to their tables, folded the stuff and deposited it on another pile two steps to the left. That had always been the practice; no one had ever thought to question it. But the investigator saw the waste of it the first day.

After many experiments with several folders, he rearranged the tables so as to cut out four of the eight steps each piece had cost. Next he analyzed and timed the detail motions in folding, determined the swiftest and easiest way to perform each, and made the sum of these the standard method of folding. With the same force and equipment, that department is delivering twice its former output now and congestion has disappeared.

Individual judgment had always obtained here in the dyeing department. The formulas in use had been worked out by the foreman by rule-of-thumb. The investigator called in the aid of chemistry and determined, after an exhaustive series of experiments, what the standards for dyes should be, what quantities were needed to dye any given run of cloth a certain shade, how long the stuff should remain in a vat and what ef-

fect temperatures and other physical conditions had on the result. The outcome was that production was nearly doubled, consumption of dye-stuffs and the cost of the work were reduced and the colors, for the first time, were predetermined and kept uniform.

One more illustration to clinch the truth that the complex and long established business offers as fertile a field for investigation and standardization as the struggling new factory or the mill where "repeat" operations are the rule. The Yale & Towne works at Stamford, Connecticut, employ 3,000 men, produce four or five million dollars worth of goods every year, and make about 100,000 different articles. The company had the prestige of forty years behind it. Its president, Henry R. Towne, was a manager more than ordinarily capable. The time came, nevertheless, when the advancing cost of labor, materials, and other expenses, compelled either an upward revision of prices or increased factory efficiency.

The latter was the company's necessity. Scientific methods have been introduced into two departments representing twenty per cent of the total capacity and the work of investigation and standardization is going steadily on in other shops. In the two already reorganized, output has climbed twenty-five per cent, important reductions have been made in labor and overhead charges, quality has been bettered, and final costs lowered from ten to forty per cent.

Production labor costs have been slashed, in operations selected at random, as follows:

No. 1.......74 per cent		No. 5.......28 per cent	
No. 2.......16 "	"	No. 6.......16 "	"
No. 3.......18 "	"	No. 7.......34 "	"
No. 4.......35 "	"	No. 8.......63 "	"

Overhead expenses show even a wider range in the reductions, as suggested below:

No. 1	.......78 per cent	No. 6	.......46 per cent
No. 2	.......30 " "	No. 7	.......17 " "
No. 3	.......18 " "	No. 8	.... 4 " "
No. 4	.......40 " "	No. 9	.......11 " "
No. 5	.......45 " "	No 10	......28 " "

These are individual instances which give a fair idea of what concentration on time-study and standardization has accomplished generally. In one instance noted there was a ten per cent increase in an overhead item, but this was offset by a reduction of twenty-seven per cent in the direct labor cost of the operations involved. Mr. Towne, himself, sums up the results thus:

Better products. Higher efficiency of workmen. Increase of output of both machines and men, per square foot of floor space. Substantial reduction of costs. Twenty to twenty-five per cent increase in wages. Lower selling prices in the average.

But the factory and machine shop are not the only fields where efficiency principles may be applied with profit. In an eastern office employing 120 clerks an investigation was undertaken to determine the best way of performing the ordinary operations of bookkeeping, filing, correspondence, and so on.

Stop-watch studies of the entry clerks showed that a reasonably continuous performance of their duties, allowing necessary intervals of rest, would clip two hours a day from the time consumed. These two hours were taken up in conversation, in reading newspapers and in divers unnecessary movements of a personal nature. It was further revealed that varying methods of handling books and blanks caused loss of many minutes. Experiments were made to learn, for example, whether spindles

or wire baskets should be used for temporary filing of order blanks. The latter were substituted so that differing forms might be sorted at the time they were handled, instead of going on to a spindle and being sorted afterward. Even the size of these baskets was considered, because if a basket was too large time was lost in straightening the forms and getting them into a compact bundle when they were removed. All these little details were analyzed and the best way determined for each.

Stop-watch study of stenographers showed similar loss of time. Repeat operations were tested to determine the normal maximum number of lines to be written in a time unit of six minutes. Most of the operators accomplished forty per cent additional work when placed under instructions and freed from hindrances. Much of the lost time had been due to conversation, "visiting," bad arrangement of machines and light and poor equipment. Many of the typewriters' tables were several inches too high; chairs were not suitable; lights were insufficient or badly placed; no scheme of arranging desks had been followed to reduce steps; no system was in effect for the care and maintenance of machines at high efficiency. Furthermore, no standard of machine had been adopted: half a dozen makes were in use.

In this investigation the health of the workers, many of them young women, was considered. Physical or nervous strain was rigidly tabooed and a normal maximum of performance was adopted with due regard for periods of rest. Yet after a year of investigation and reorganization of office procedure, sixty clerks and stenographers did the work formerly done by 120, simply by doing each operation in the best way.

In another office analysis of the work of the mail-clerk showed that he performed double the number of movements necessary in sorting and distributing his letters. Study of the files disclosed false motions and badly arranged cabinets, causing sixty per cent loss of time. In filing documents the clerks worked from one big heap, picking up each document separately and walking with it to its proper file. Sorting in advance according to a standard method and filing from a wheeled table cut out all the unnecessary steps. Files were rearranged and forms changed to a uniform size.

Like inquiry reorganized the work of the sales-clerk, receiving-clerk, bookkeepers, cashier, and other departments. In the shipping department the goods moved in duplicate currents which required unnecessary checkers. When the entire volume was switched to a single channel, three checkers working continuously, were able to do the work formerly performed by six. In the storeroom it was discovered that office supplies were carried in larger quantities than was necessary, resulting in deterioration and waste. The solution was the introduction of a standardized stores system, which will be described in a future article.

Every repeat operation in the office, so far as possible, was reduced to a standard. The investigation showed a wide variety of methods among employees in accomplishing the same end. In the arrangement and care of desks, inquiry showed that a great saving of time could be effected by standardizing. All unfinished business, for instance, was required to be tagged and placed in certain receptacles at night, so that unexpected absence of an employee next day might not cause confusion. One drawer in each desk was set aside for personal belongings, and this drawer alone was allowed to be locked.

The results of this investigation were reduced to a systematic series of instructions and definitions contained in two large scrap-books known as the "Book of Standards" and the "Book of Directions." The former prescribed and classified the various functions of the business and the means of executing them, such as forms, equipment and supplies. The latter supplied specific instructions as to every *repeat* operation and told how to use the forms, equipment, and supplies.

You create a standard when you seize upon the expert method in your business, improve upon it by direct experiment, and make it therafter the routine method for all. Standardization is the establishment of a definite ideal, whether that ideal be a machine, a tool, a material, a process or an operation.

You can standardize the sweeping of your office or the washing of the windows, provided you first determine the best and shortest way to perform those operations. The standardization of sweeping is not the simple thing it looks. In one plant it occupied six months of study, which included long experiments with different forms of brooms. To standardize is never simple if you really mean the standard to be the best. The standardization of equipment in machine shops has occupied a group of mechanical engineers many years, but these long experiments have resulted in mathematically accurate slide-rules for determining the pulling and feeding power and the speeding of machine tools.

Wherever an expert has investigated a shop under ordinary management, he has found no standards for these things except in the judgment of the machinists and in other matters investigators have found an equal lack of standards, from shop to office.

CHAPTER IV

Balancing Stock Room Supply and Demand

THE first problem in the scientific arrangement of an office, factory or shop store-room is classification of its contents. The ordinary way is to classify its contents by size, and the unscientific storekeeper regulates this detail himself. He puts materials in whatever receptacles he chooses, and changes them around as the whim dictates. Sometimes he keeps bin-tags showing the name and quantity of each item on hand; oftener he does not. The problems of replenishing stock are largely left to his individual judgment, and either too much capital is tied up in stores, or stock runs out and causes delay and loss in other departments.

The scientific manager, on the other hand, arranges his store-room in accordance with a scheme that divides and subdivides stores into groups, with reference to *use*, not size. In the store-room of a highly organized plant in Philadelphia where the principles of scientific management have been successfully applied in detail, the mechanism of the store-room system embodies several features that are generally applicable to similar departments of other concerns, and in slightly modified forms, to the store-rooms of offices and retail establishments.

When this plant undertook to change its store-room from the old, haphazard plan, the first task was to determine the groups into which the various items of stores fell. For example, the company manufactures, as one of its products, molding machines. All material for molding machines, then, came logically into one class, which was designated by the mnemonic symbol M. But there were several kinds of such machines, so this group was subdivided. Hinged molding machines were designated by the letter H; power-ramming molding machines took the letter P; molding machines of the "jarring" type received the symbol J. In like manner other mnemonic symbols, designed to assist the memory and thus to reduce the clerical labor required to operate the department, were employed.

So to designate the subdivision containing, for instance, power-ramming machines for molding, the letters MP were used, and every employee in the department soon came to know them by the symbol. It was vastly easier and quicker to write "MP," than to set down the full title, "Power-ramming molding machines."

But there were various materials used in manufacturing and assembling the power-ramming machines, so a further subdivision was made. The symbol MPB was taken to signify the base group of materials used in power-ramming molding machines. Carrying the classification even further, MP1B indicated the first piece in the group.

Similarly, MPBB was synonymous with "strain-bar division of the base group of power-ramming molding machines," though in this instance the final letter was not mnemonic; that is, it was not a letter that recalled anything to the memory. It is not possible to make the combinations altogether mnemonic without conflicting,

but it must be noted that all of these symbols are recorded and indexed, and, once established, may be found in key lists, each group being kept by itself, for instant reference.

STORES TAG NO. S		CHARGE TO ORDER NO.		
QUANTITY	UNIT	TOTAL WEIGHT LBS.	TOTAL VALUE	
DESCRIPTION				

STORES ISSUE

STOREKEEPER

MR.__________ } DO NOT FILL OUT NAME FOR ORDERS ON STOREKEEPER

MONTH	DAY	YEAR
		19

PLEASE ISSUE ABOVE { TO__________ TO BEARER

SIGNED__________

AP-POR-TION-ED	ENTERED TAG	STORES ACC'T	BAL. ACC'T	COST ACC'T

STORES DESCRIBED ABOVE HAVE BEEN ISSUED

SIGNED BY STOREKEEPER OR HIS REPRESENTATIVE__________

This slip is a requisition on the storekeeper for material or supplies needed in the factory or office. It is issued by the planning department—to which it is returned after the stores have been issued. From it are made the stock entries on balance-of-stores sheets, and also the cost ecords

When all materials and supplies had been classified on paper in accordance with this scheme, including supplies used in the office, the physical rearrangement of the store-room was begun. All the old bins and shelves were torn out, and new tiers built. They occupy the outer circumference of the room, and also extend across it at regular intervals. The unit of space adopted was twenty-four inches, and the shelves were divided into square

compartments of that size. Then, following out the necessities shown in the classified tables of stores, each compartment was subdivided into smaller compartments and bins, which, in dimensions, were aliquot parts of the larger unit.

The stores were then sorted and placed in their new positions. The locations of the items were shown by indexes posted at the ends of the tiers, as shown in the accompanying illustration. These indexes show only the symbols, for it was found unnecessary to translate them into word descriptions. These symbolic indexes appear in alphabetical order, so that the storekeeper can find any given item without loss of time. The tier indexes follow each other like the pages of a city directory. Suppose, for instance, the storekeeper wants an article the symbol for which appears on a slip of paper he has before him: "SV⅝x3ZH." Perhaps he does not know what the article is, except in a general way, but he passes many of the tiers without looking at them, just as he would turn to the back of the S classification in the city directory to find a name the first two letters of which were SV. Pausing at the SV tier, he finds the H bin of the Z subcompartment. Now he observes that the size of the article he wants is ⅝x3 inches. All the sizes are arranged in little bins together, and each bears its label, so the storekeeper takes out instantly the thing he wants, a hex-head bolt.

Under the old system, nobody except the storekeeper could have found this article without extensive search; even the storekeeper himself might have spent ten minutes or more in locating it. Besides, the lack of an abbreviated system of identification would have necessitated writing out the description in full, perhaps on numerous blanks.

The procedure is the same, whether the item wanted is a lead pencil or a blow-valve.

But the storekeeper in the efficiently organized plant is not now the czar that he once was. He no longer does any planning; he merely executes. All the recording, aside from the keeping of the figures on the bin-tags, is done in the planning department, and all orders on the store-room come from the same source.

When the company receives an order from a customer, it follows a procedure comprising four general steps. First, it issues the manufacturing order; second, it makes the drawings; third, it analyzes these drawings in the planning room and routes the work through the factory; fourth, it apportions the necessary material. It is in the fourth step that the planning department comes in touch with the store-room. The planning clerks make out a batch of stores-issue slips, like the one shown on page —, and these slips are sent to the storekeeper by the "move-men." Each slip is a requisition on the store-room for specific material. If the articles called for are small, like bolts or screws, they are collected, each kind by itself, in a "tote-box"; if they are large, the "move-men" carry or truck them out piece-meal. As soon as the storekeeper has issued the material called for by a stores-issue slip, he so certifies on the slip itself. This is returned to the planning department, and from it are made the stock entries.

It frequently happens, however, that several weeks must elapse before some of the material on a given order will be needed, such, for instance, as manufactured parts for assembling. But the planning department makes out all the stores-issue slips at the start, holding back those not needed immediately in the store-room. Now the balance-of-stores sheets play a conspicuous part.

BALANCE OF CLASSIFIED STORES — A S 10

DESCRIPTION ________ WHEN QUANTITY AVAILABLE FALLS TO ________

ISSUE REQUISITION FOR ________

NOTE:—WHEN STORES ARE ORDERED, ADD THE QUANTITY TO COLUMNS 1 AND 4. WHEN STORES ARRIVE, SUBTRACT THE QUANTITY RECEIVED FROM COLUMN 1 AND ADD THE QUANTITY RECEIVED TO COLUMN 2. WHEN STORES ARE APPORTIONED, SUBTRACT QUANTITY FROM COLUMN 4, AND ADD QUANTITY APPORTIONED TO COLUMN 3. WHEN STORES ARE ISSUED, SUBTRACT QUANTITY FROM COLUMNS 2 AND 3. IN ALL CASES BRING DOWN AT ONCE BALANCE ON HAND IN EACH COLUMN AFFECTED.

STORES ORDERED-1 BUT NOT YET DELIVERED					STORES ON HAND-2 IN THE STOREROOM					STORES APPORTIONED-3 TO AN ORDER BUT NOT YET ISSUED FROM STOREROOM				STORES AVAILABLE-4		
DATE ORD'D	NO. OF PIECES OR QUANTITY	DATE REC'D	PURCHASE ORDER NO.	DATE TO BE DELIVERED	DATE REC'D	NO. OF PIECES OR QUANTITY	DATE ISSUED	ISSUED FOR ORDER NO.	PURCHASE ORDER NO.	DATE APPORTIONED	NO OF PIECES OR QUAN.	DATE ISSUED	ORDER NO.	DATE	NO. OF PIECES OR QUAN	REMARKS

The above form illustrates the manner of keeping track of stock. A reading of the note at the top of the sheet will give the key to the system of entries as shown by the figures entered in ink. These balance-of-stores sheets are bound in loose-leaf ledgers and kept in a special indexed cabinet. There is a sheet for every item of stores

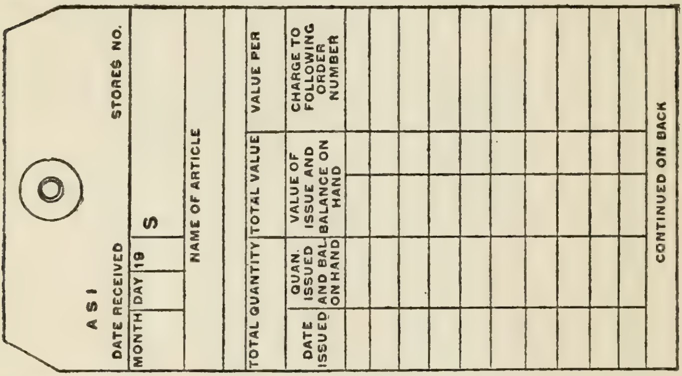
Primarily, these sheets make up the stock ledgers, each sheet showing the balance on hand of a given item in the store-room. But the sheets show more than this. As soon as the material has been apportioned for a manufacturing order, even if parts of that order will not be needed for weeks, entries to that effect are made on the balance-of-stores sheets. In other words, all the material is charged to the stores, just as a certified check is charged by a bank to the account against which it is drawn. The check may be outstanding for a month and the money remain in the bank, but the cash is not available for any other purpose. What the planning department wants to know is the quantity of each item of stores that is *available.*

One of these balance-of-stores sheets is reproduced on page —. The first column shows the quantity of stores ordered but not yet delivered; the second column gives the quantity on hand in the store-room; the third column sets forth the quantity apportioned to an order but not yet issued from the store-room; the fourth column reveals the net quantity. The method of making the entries and bringing them down may be learned from the note at the top of the sheet:

"When stores are ordered, add the quantity to columns 1 and 4; when stores arrive, subtract the quantity received from column 1 and add the quantity received to column 2; when stores are apportioned, subtract quantity from column 4 and add quantity apportioned to column 3; when stores are issued, subtract quantity from columns 2 and 3. In all cases bring down at once balance on hand in each column affected."

At the top of each sheet, too, appears a double line:
"When quantity available falls to ....
"Issue requisition for ....

In this way the balance-of-stores clerk in the planning department keeps an automatic check on each item of stores. The balance-of-stores sheets are made up in the form of loose-leaf ledgers, indexed in accordance with the mnemonic classifications; without consulting the storekeeper, the clerk can tell in a moment the number or quantity of a given item on hand, or actually available. Under the former method the storekeeper kept the records. He did not know what work was planned to come through, and often he was taken by surprise and the necessary items of stock were found wanting.



A tag like this is hung on a hook attached to the bins and shelves in the store-room. On it is kept the only records made by the storekeeper. All other store records are kept in planning department

In order to verify the stock on hand, the balance-of-stores clerk spends an hour a day in the store-room, checking up. Each day he takes a certain number of items and counts or weighs them, comparing the result with the figures on his sheets. To go through the whole store-room requires six months, so that during the year two full inventories are taken.

This system has been working smoothly for several years, and has been found a heavy conserver of ma-

Plate VI: The one best way of doing the thing has been worked out in this method of handling and storing tools. This corner of a tool room illustrates the axiom of order—a place for everything, everything in its place. In the raw and finished material storeroom, systematic methods of handling stock are necessary to the scientific conduct of the business. The stockrooms are part of a big general plan of getting the right material to workmen on time. To this end a balance-of-stores system is maintained which keeps stocks ahead in sufficient quantity to insure. By combining a schedule of work with a balance-of-stores system, the planning department can insure the economical laying out of next day's work

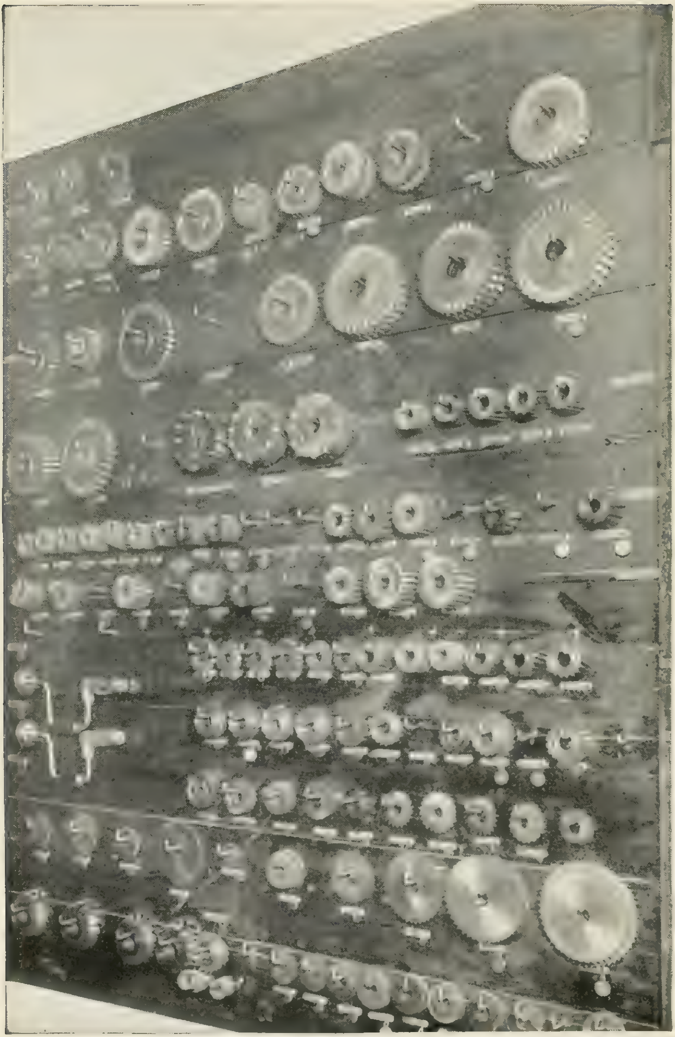
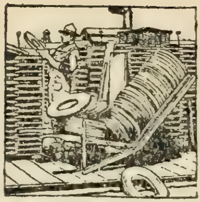


Plate VII: A section of the reverse tool room in a plant under scientific management. At the right, notice that the mnemonic symbol for each tool is on a little card above it

terial, insuring against waste in store-room, shop, and office. It has been of great service, too, in furthering the dispatch of work by providing against lack of material.

The great difficulty frequently encountered in the installation of such a stores system is lack of thoroughness in the preliminary work. The most important task is the classification. To do this properly requires patient study and a complete working out of the groups before the physical part of the change is begun. This is especially important if the mnemonic symbol system is to be used, for wrong groupings will be just as confusing as a mistake would be in paging a city directory. Therefore, if the factory or office is of a size sufficient to warrant, expert assistance is desirable. Without the mnemonic system, the undertaking is simplified in the beginning, but an ever-increasing amount of clerical labor is made a certainty. Indeed, some system of abbreviations is necessary to the conduct of an efficient storeroom, just as it is to the tool-room. It is not economical management to write out, laboriously, the name of every item or tool, with its full specifications, any more than it would be efficiency today for the typewriter operator to take dictation in longhand.

But those who do not care to use the mnemonic system can, if they wish, use a system of numerals, or invent some short-cut in the art of designating and storing articles. The mnemonic system, however, is in general use wherever scientific management is followed, and is giving universal satisfaction. But the installation of such a system is not to be lightly undertaken by the man who has made no full study of it.



CHAPTER V

Putting Standards Into Practice

FINDING the one best way and adopting the expert method as the standard for every operation and process is only the preliminary step in scientific management. To get results in the shape of lower labor or production costs, increased output or bettered quality, these standards must be applied inflexibly in practice. Right here it is that this type of organization parts company once and for all with the ordinary or military type of organization in force in ninety out of every one hundred businesses.

Study of detail processes, analysis and experiment to determine the most suitable materials, the best equipment, the most effective methods, have been prosecuted in some degree by every executive worthy of the title. The success of any undertaking, indeed, usually can be traced to the short cuts or other economies discovered and enforced by its builders. Time-study—more properly motion-study—and the standardization of methods, equipment and materials, as understood by efficiency managers, might even be carried out by organizations of the military type.

But when application of these standards to the day's work begins, the fundamental shortcomings of the old

scheme of management appear. It would be an extraordinary foreman or mechanic who could grasp, digest and select from all this harvested knowledge the exact standards to apply to each particular job. And the mental capacity of the executives would be only one of several factors limiting the results.

Several years ago Frederick W. Taylor, the creator and prophet of the "efficiency" movement, pointed out the fact that, lacking all-around geniuses for foremen, the practical course was to make specialists of the bosses by enlarging their individual fields and decreasing their functions to such as each was fitted to master and perform. He counselled the "abandonment of the military type of organization and the introduction of two broad and sweeping changes in the art of management."

"First," he urged, "the workmen, as well as gang-bosses and foremen should be entirely relieved of the work of planning and of all clerical work. All possible brain work should be removed from the shop and centered in the *planning* or *laying out department*, leaving for the foreman and gang-bosses work strictly executive in its nature."

The second change advocated was the adoption of "functional management." The old military organization grouped men in departments, each under a single foreman who exercised, so far as his time and ability permitted, all the functions of the management in its relation to the men and the work. The new way divided these functions among several bosses, limiting each, where possible, to a single leading line, but bringing all of them (except the gang bosses) into contact with all the men. Thus every workman became a member of seven or eight groups and received orders, in-

structions and help direct from as many bosses, each a specialist in his own field.

Four of these functional bosses are in the planning room—the order-of-work clerk, the instruction card man, the time and cost clerk and the shop disciplinarian. The first three transmit orders or receive returns from the men chiefly in writing. Four other types are out in the shop, in personal contact with the men and helping them in their work: the gang boss, speed boss, inspector and repair boss.

Other names have been tacked to these functional bosses in various plants: in a few the functions of two or three have been consolidated or assumed by others of the eight. But the functions themselves remain and are performed; the vigor and success of the scientific management are due partly to the care with which it may be adapted to meet conditions in the individual business. The division of functions is clear. The planning department analyzes and lays out the work, studies and perfects materials, methods and equipment, fixes standards: the shop executives see that the directions of the planning department are carried out exactly.

Let us look at the planning department first—this wonderful collective brain of the factory which performs so many functions and focuses so many kinds of expert knowledge on every detail it handles. Its activities may be summarized under eight heads:

1. Time-study for all hand-work, including setting work in machines and assembling. Time-study for all machine operations.

2. The fixing of standards for each operation, based on these investigations plus experiment.

3. Analysis of all orders accepted by the company: the determining of what must be manufactured, what

taken from stock, what bought, the analysis of every part required, and of every operation on each part. The issuing of instruction cards covering these operations. The routing of each part. The follow-up on work in process.

4. The balance of all materials, stores and finished or unfinished parts. The balance of work ahead for each class of machines and workmen.

5. Analysis of all inquiries received by the sales department: promises on time of delivery.

6. The cost of all items produced. Complete monthly expense analyses and comparative costs and expense exhibits.

7. The maintenance and improvement of the system, standards and plants.

8. A mnemonic symbol system for identification of parts, operations, machine tools and charges.

To these functions various planning rooms add other activities—the rush-order department, the pay department, the information bureau, messenger system, employment bureau, maintenance and improvement of the system and plant, a mutual accident and insurance association and the shop disciplinarian. Mere reference to these is enough in this article. The purpose of each and its relation to the main work of the department are obvious.

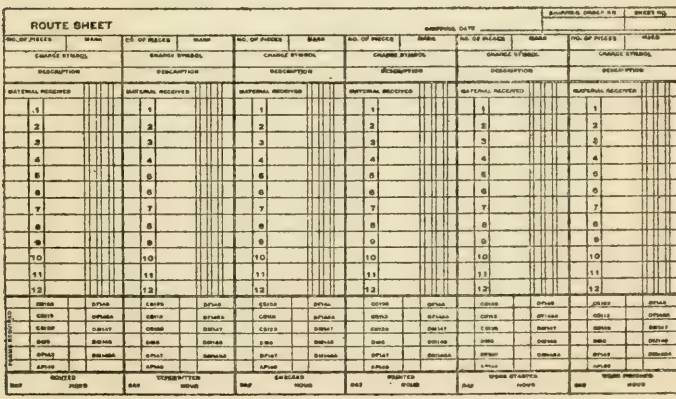
Two of these functions, time-study of all hand and machine operations and the standardization of these operations, equipment, materials, tools, and so on, were dealt with in the article of this series printed last month. They are preliminary activities, since they supply the information on which the planning department bases its production orders, instructions and schedules. But they never cease: the time-study man and the rate fixer are

important factors in every planning department. Neither gang bosses nor workmen have authority to alter methods or ignore the directions on the instructions cards. Should either discover a new short cut or economy, the suggestion goes to the planning department for investigation and approval before it gets a place among the shop standards.

It is with the third function—analysis of all orders accepted—that the planning department begins to have a direct effect on production. In some departments, as in the Link-Belt factories, the first official to receive the order is called the "production clerk." It is his business, first to know or to have at hand information on the number of days of work ahead of every machine and man, or every group of allied machines, and second to resolve each new order into its elements, and determine what machines will be occupied with it and how soon deliveries can be made. The advantage of concentrating all planning in one department comes out here: if the production man needs specific information not in his possession (either on orders accepted or inquiries received by the sales department) he can consult instantly with three other men able to supply any details he lacks—the time-study man on unfamiliar operations, the route clerk on the future capacity of standard and alternate machines, and the balance-of-stores clerk on stock, materials and supplies on hand or to be purchased.

The latter makes the second analysis of orders received, comparing its requirements with his records of stock on hand, finished, partly processed and raw; determining what stock materials or parts can be used, what must be purchased outside (either materials or parts) and he makes requisition either on stores or the purchasing agent for the parts or materials and supplies

needed. He indicates the group of machines to which they are to be sent and when; adding the invoice price or standard production cost. Perforce he is responsible for the various stock departments and the maintaining of the proper balance of stores. The system through which reserve stocks are kept at proper level (duplicate bins alternating as receiving and issuing bins to insure fresh stock always) will be described later. Third in line, the route clerk analyzes the order from the work standpoint. With the balance-of-stores information and the delivery date before him, he applies the shop standards to each part or lot of parts to be manufactured and prepares an instructions card covering each phase of its making and finishing, including the patterns, templets, jigs, and so on, needed, the standard type machine on which each operation is to be done, the exact sequence of these operations, the tools to be used, the speed and feed and the routing of the part from machine to machine, with dates.



Every order, large or small, has its route sheet on which the separate machines or members are analysed into their constituent parts and the course which each part is to follow from department to department and machine to machine is laid out step by step. In the bottom margin, note the time checks on the work, both in the planning department and the shops

The route-board man, or order-of-work clerk posts these instructions cards against the various machines, shuffling them when necessary to expedite the rush order, substituting alternate machines when the standard machines are over-crowded; keeping the job-in-hand, the next job and future jobs for each machine carefully segregated on the planning board. In some efficiency plants this planning board (and the entire department), is central and easily accessible to all the gang bosses; in others, each department or gang boss has a detail board which is virtually a section of the main planning board.

In some factories, too, messengers deliver the instructions cards directly to the machines indicated on them; in others to the gang bosses; in still others, the route clerk hands out the instructions cards, and files and delivers blue prints to the gang bosses at his window. This mechanism of delivery, or the added duties of the route clerk are details susceptible of change, so long as no loss of time is incurred by bosses or workmen. A time-clerk receives the instructions cards, or work-tickets, on completed jobs, writes in the rates, makes the proper extensions and rewrites the cards on unfinished jobs.

All this indicates the organization by functions rather than by individuals. A plant may be so large that each of the men named above may need one or several assistants. The routine work, copying or printing of orders, keeping records and the like can be done by boys just out of grammar school. In one typical planning room, serving a plant with three hundred workmen, the balance-of-stores clerk has two assistants, the route clerk two, the route-board man one; while the "production man," the time-study man, the rate-fixer and the time-clerk all get along without help. Three additional boys

are copyists, clerks and messengers by turns. This factory has been organized along efficiency lines for years; the time-study man and rate-fixer are concerned, of course, only with the making of specially-designed machines and the revision of current standards.

In carrying out the directions and schedules of the planning room, four types of functional bosses are required: *gang-bosses, speed-bosses, inspectors* and *repair-bosses.* All of these come in direct contact with the workmen—the gang-boss continuously, so far as the workmen in his group are concerned, the other perhaps only once or twice daily with each worker. In some of the older efficiency organizations, indeed, the gang-bosses have absorbed many of the functions of the speed and repair-bosses—the bonus or premium plan of payment increasing familiarity with speeds and feeds on the part of the workmen and thorough understanding of the advantages of working with perfect tools making continuous supervision less imperative.

Care of equipment, however, the tension of belts, and like details cannot be left wholly to the initiative of the gang-boss. His first duty is the teaching and supervision of the men in his group—to interpret the instructions of the planning department; to demonstrate the methods specified, when necessary; to make sure that the directions as to tools, speeds, feeds, sequence of operations, and so on, are carried out. In the first months after a reorganization begins, the regular speed boss, the inspector and repair-boss must follow the workmen closely to make sure the standards are observed. As the advantages of the standardized methods become clearer and clearer, and obedience (with its bonus rewards) becomes second nature, the gang-bosses can be depended upon more and more to keep their men up to the mark

in every detail that effects top efficiency, and to cooperate in the up-keep of machinery, belts and tools.

With the passing of the old military system of control and the changed relations of bosses and workmen, provision must be made for maintaining discipline. A boss cannot be a teacher or helper one minute and a policeman the next; exercise of the latter function would jeopardize his efficiency in the other. To meet this contingency, a shop disciplinarian is appointed whose business it is to take in hand any workman or boss who refuses or neglects to follow the instructions of the planning department or otherwise departs from the fixed standards of the shop. In some instances he is the head of the planning department; in others the superintendent or assistant superintendent of the works. Usually the work is allotted to him because of natural fitness rather than because of his position in the organization which does not bring him into daily contact with the men whom he must occasionally "bring to time."

Mr. Whitman
JDH/GP

Dec. 5, 1910.

TURNING DEPT.

For the ensuing week please arrange to spend time as follows:

Job 177	Finish	Job 194	20 hours
Job 187	400 hours	Job 195	20 hours
Job 188	400 hours	Job 197	32 hours
Job 192	20 hours	Job 198	64 hours
Job 193	20 hours	Job 199	196 hours

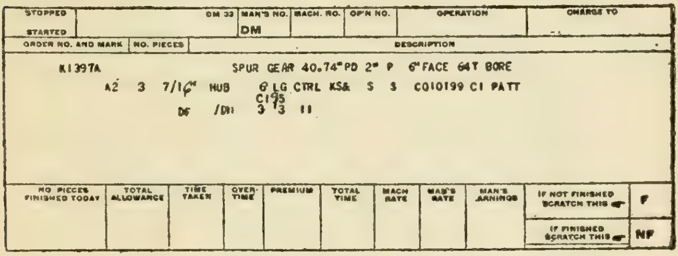
For the month of November you were 72.9 per cent in capacity, 93.4 time on bonus, and 103.5 efficiency of workmen, making a total of 86.4 points for the month.

This is an example of a "Weekly Letter" of a factory manager to the head of his turning department. This plant is planning to add to its efficiency figures: Percentage showing efficiency secured in shop capacity as a whole, cost of production, and of time schedule for finishing jobs

This is functional or scientific management from the organization side. To see it in action—study it from

the viewpoint of its effect on the workman and his work, let us take a typical industry: a small machinery concern employing only one hundred men in its shops, but having twenty men and boys in its planning department. Despite its modest size, the fullest application has been made of the principles of detail study and functional management. With this result: from an unprofitable basis it has been raised to a condition of substantial earnings: output has more than doubled without any material increase in plant or equipment: wages have increased, but labor cost and total production cost have both been reduced.

Formerly, as in most shops, the mechanics did a large part of the planning how work was to be done. They


STOPPED
STARTED
DM 33
MAN'S NO.
DM
MACH. NO.
OP'N NO.
OPERATION
CHARGE TO
ORDER NO. AND MARK
NO. PIECES
DESCRIPTION
K1397A SPUR GEAR 40.74" PD 2" P 6" FACE 64T BORE
A2 3 7/16" HUB 6 LG CTRL KS& S S C010199 CI PATT
C195
DF /DH 3 3 11
NO PIECES FINISHED TODAY
TOTAL ALLOWANCE
TIME TAKEN
OVER-TIME
PREMIUM
TOTAL TIME
MACH RATE
MAN'S RATE
MAN'S EARNINGS
IF NOT FINISHED SCRATCH THIS
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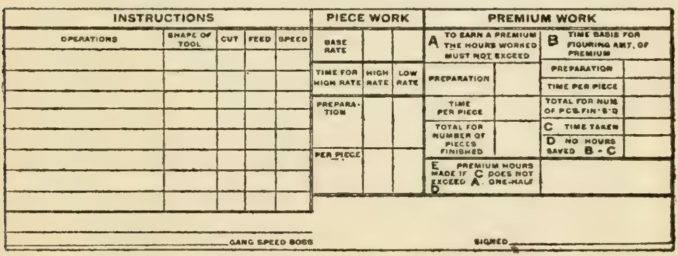

INSTRUCTIONS
OPERATIONS
SHAPE OF TOOL
CUT
FEED
SPEED
PIECE WORK
BASE RATE
TIME FOR HIGH RATE
HIGH RATE
LOW RATE
PREPARATION
PER PIECE
PREMIUM WORK
A TO EARN A PREMIUM THE HOURS WORKED MUST NOT EXCEED
PREPARATION
TIME PER PIECE
TOTAL FOR NUMBER OF PIECES FINISHED
B TIME BASIS FOR FIGURING AMT. OF PREMIUM
PREPARATION
TIME PER PIECE
TOTAL FOR NUM OF PCS FIN'S'D
C TIME TAKEN
D NO HOURS SAVED B - C
E PREMIUM HOURS MADE IF C DOES NOT EXCEED A. ONE-HALF D
GANG SPEED BOSS
SIGNED

On the front of the card (above) are typewritten the specifications of the part to be made, with the description in mnemonic symbol. Spaces are provided for indicating every detail connected with the operation. On the reverse of the card (below) instructions to the workman are filled in for each operation, the tool required, the cut to be made, toe feed and speed, with the base rate, the time allowed for the high and low rate and premium work

studied their blue prints and decided what operations were necessary, which should come first and how they should be accomplished. They hunted up the machine tools they needed, borrowing them with or without permission. They drove their planers or lathes at whatever feed and speed they thought right. Finishing a job, they left their tools where they dropped. The next man to need them conducted his own search for them, lost time putting them into condition again or used them as they were at half efficiency. They "soldiered" by the hour at times on "fill-in" jobs while waiting for castings or drawings for their principal tasks. To list all the wastes would take pages; few manufacturers need to be told of them, however. They know.

Today, the workmen do no planning. Every detail of work on every job is thought out for them and put down in unmistakable black and white. Not merely general directions but the specific instructions indicating operations necessary on each part and the factors bearing on these operations—the character and number of cuts, the depth of each, the tool to be used, the speed, the feed, the time allowed if a bonus or premium is to be earned, the hourly rate if the bonus time is not attained. Analyzing the drawings and specifications, the planning department reduces each machine or group of machines ordered to its primary elements and prepares an instructions card for each part or lot of similar parts required. Each operation has been standardized: the standards are either carried in the planner's brain or in a convenient file: the instructions card carries these to the workman and his gang-foreman.

Materials, whether castings or raw stock, have been requisitioned and forwarded in the same exact fashion. The proper machine tools, templets, jigs, have been pro-

vided. The lathe, planer or drill press itself is in prime condition: belts are kept religiously at the right tension. The gang boss is at hand to explain or demonstrate how the instructions are to be carried out, should there be any doubt in the workman's mind. The interest of the gang boss is as keen as the workman's: his compensation increases according as the members of his group earn their bonuses.

How minutely the work is planned and prepared for in this factory may be illustrated by the standards maintained for the bolts used to clamp work on the machines. In the average shop, these bolts lie around on the floor: rarely is there a full assortment accessible. Needing four-inch bolts, say, the mechanic looks around for them, fails to find a full set, and concludes to use six-inch bolts. Blocking up is necessary and he probably has to screw the nut down an extra inch. Because of the rough care the bolts get, the thread may be damaged and he has trouble in getting the nut down. In many cases, as motion studies and observations have shown, he consumes from ten to twenty times as many minutes as the clamping ought to take.

Now, each instructions card specifies, in hundredths of an hour, the time allowed for setting the work in the machine. Such specification would be useless, of course, unless the proper blocks and bolts were provided for the workman's use. So the planning department sees that a full supply of bolts and blocks of varying lengths are kept in the tool racks. With each job, the mechanic receives the particular size of bolt best suited to the task, just as though these were standard machine tools instead of accessories usually neglected. Furthermore, before they are restored to the rack after use, every thread and nut is inspected to make sure they are still

in perfect condition. Try any bolt in the tool room and the nut turns easily under your fingers.

Except by comparison of the time consumed in certain operations before and after the reorganization, no conception can be gained of the unbelievable wastes attending some of the less common processes. In the erecting rooms, not long since, one assembler did nine times as much work under functional management as he did under the old system. Because orders for this particular machine were infrequent and the parts unfamiliar to the clerks in finished stock (itself poorly organized) he had been obliged to hunt up many missing parts himself. Now every part has its symbol and its place in the stores room; every operation in assembling has been standardized. Before he starts work, the planning department has delivered every member of the machine or arranged to supply it on a schedule which will not keep him waiting. His instructions card tells him more about the job than he knew when he monopolized the factory's information about it.

The same scrupulous regard for details is carried into the storehouse, where a standard balance of raw and finished stock is maintained at all times. The balance-of-stores sheet reflects this faithfully and allows the planning department, in analyzing an order, to determine in the briefest time whether all the parts or materials to fill it are on hand or must be manufactured or purchased. This balance-of-stores sheet not only shows how many units of a given article or material are on hand, but also the number apportioned to future jobs, the minimum to be kept in stock and the maximum allowed. Over-investment in stock is thus guarded against; likewise lack of material or parts which might cause delay in the shops and belated deliveries.

Stock and supplies are received from the shops for credit, as well as issued. Ten quarts of turpentine, for instance, may be given out for a specific purpose; only nine are used. In the old days the extra quart would stand around until it evaporated. Now it is returned on a store's credit tag and the job credited for the amount. Or again, a rod or bar, cut too small by mistake, is saved from the scrap heap by the same method.

MINIMUM STOCK	GROUP	BALANCE OF STORES SHEET
QUANT. TO ORDER	CLASS	NAME OF ITEM
	NUMBER	SPECIFICATIONS

ORDERED			RECEIVED			ISSUED			BALANCE ON HAND			APPLIED ON ORDERS			AVAILABLE		REMARKS
DATE	QUANTITY	PURCH OR STOCK ORDER NO	DATE	QUANTITY	PRICE	DATE	QUANTITY	ON ORDER NO.	DATE	QUANTITY	PRICE	DATE	QUANTITY	ORDER NO.	DATE	QUANTITY	

To keep on hand without over-investment a sufficient amount of materials, supplies, and finished or unfinished parts is an important function of the planning department. Here is the form by which the proper balance for each item is maintained. Notice that the minimum and maximum amount is fixed and that successive columns are provided to show stock ordered, received and issued, with the balance on hand, the amount applied on orders and the balance available

These are details suggesting to what lengths standardization has been carried in typical plants and how scrupulously the most trifling of these standards is applied in practice. Trifling conveys the wrong impression; scientific management recognizes no difference in kind between the waste of half a minute in a unit operation and the loss of half an hour in a process made up of many unit operations. Both spell inefficiency: the greater loss is frequently eliminated by cutting out ten or twenty or forty unit wastes.

CHAPTER VI

How a Planning Department Works

SHOP ROUTINE at the Philadelphia plant of the Link-Belt Company is governed by the Taylor system of shop management and begins, properly speaking, in the planning department. This department includes a specially trained force that lays out every detail of a job's progress through the shop—operations, order of manufacture, machines to be used, rates and speeds to be applied, and like details. This relieves the foreman of a mass of work, clerical and mathematical in nature, which has heretofore interfered with his regular duties. The department is manned by five detail clerks and its field of operations is graphically illustrated in the charts on next four pages.

The route clerk schedules jobs through the shop operations. He must know the size and capacity of every machine in the shop. The instruction-card clerk writes out the necessary time, or instruction cards for each operation. The rate-setting clerk receives the time cards and enters on each the time and rates allowed for every operation. The order-of-work clerk determines the placing of all work at the various machines, first consulting the production clerk as to their order of precedence. Responsibility for the shipment of orders on

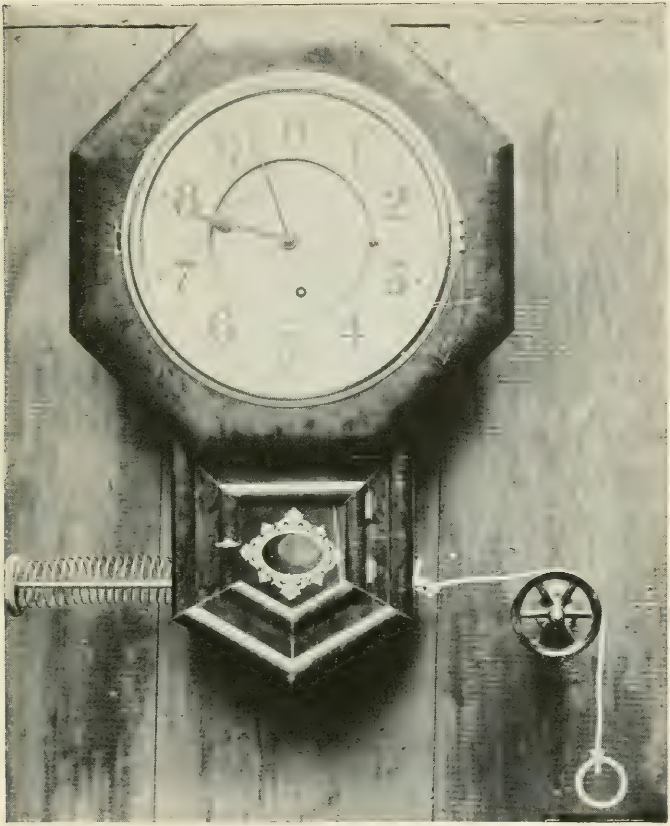
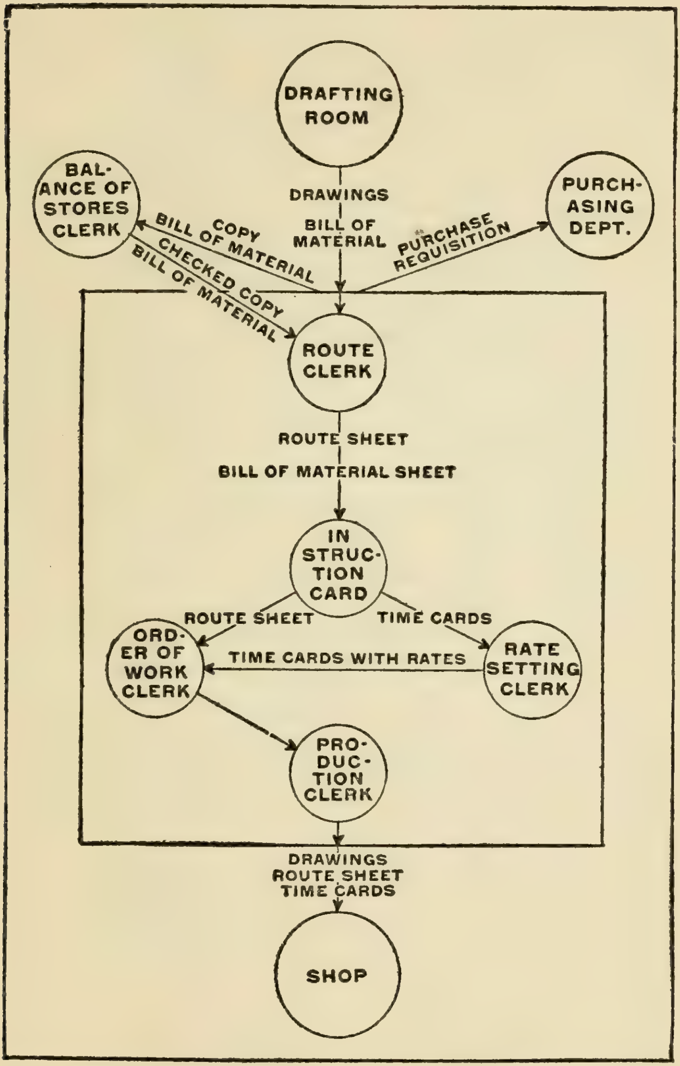


Plate VIII: Ten-Hour Clock: In efficiency plants work time is reckoned not by minutes but by hundredths of the hour. Above is a decimal system clock. Started when the whistle blows, workman take time from it. The clock is set in motion by the timekeeper each morning. It regulates duplicate clocks in every department by means of which the workman can compare the time consumed in each operation with the "standard" time indicated on instruction cards. The clock is but one detail of the machinery of scientific management yet it illustrates the refinements which are made to eliminate chances for error and make the records accurate

Plate IX: The speed boss's function is to follow up workmen on individual jobs as here shown. He is teacher as well as executive



How the orders are handled through a planning department is shown in this chart of the organization of such a department at the Link Belt Company's factory

dates specified by the sales department is delegated to the production clerk who watches the progress of all jobs through the shop. After the detailed drawings of a job, or of a machine, are completed by the drafting room, every part necessary for construction is itemized on typewritten bill-of-material sheets. These sheets are forwarded to the planning department, from whence copies are sent to all interested departments.

The balance-of-stores clerk receives a copy and marks thereon whether articles are in stock or are to be obtained by the purchasing department, and sends the copy, completely checked, to the route clerk in the planning department. Work is here started on all articles marked to go through the shop.

Suppose, for instance, that the route clerk finds from his bill-of-material that it is necessary to make a thirty-inch steel cut gear. He first starts a route sheet for this article entering the following operations: (1) bore and turn; (2) cut teeth; (3) keyseat; (4) setscrew; (5) inspect; (6) ship. Then, knowing the sizes of the various machines, he routes the operations as follows: Boring mill No. 4, gear cutter No. 3, keyseater No. 1, drill press No. 2, inspection, shipping room. Each type of machine is designated by a letter, L for lathes, B for boring mills, C for gear cutters and D for drill presses, and a number is placed before the letter to indicate the size of the machine, the largest starting at 1. For example, machine No. 8L would identify the eighth largest lathe in the shop. As all operations are shown by symbols, the route sheet for the 30 inch gear will read as in form on next page.

This together with the copy of the bill-of-material sheet is forwarded to the instruction-card clerk, who makes out a time card for each operation, entering on

each the order and sheet number, drawing number, and the description of the piece.

The bill-of-material sheet is then filed, the route sheet sent direct to the order-of-work clerk and the time cards to the rate-setting clerk. The latter has on file cards giving detailed instructions as to how each operation must be done, the speeds and feeds to run, tools to use and all information regarding the machining of the piece.

ROUTE SHEET

NAME OF PART

30" Steel Cut Gear

Machine	Operation	
4 B	No. 1	B & T
3 C	2	C T
1 K	3	K S
2 D	4	S S
	5	I
	6	C W

The route sheet like the above form is typewritten for each job, in the planning department

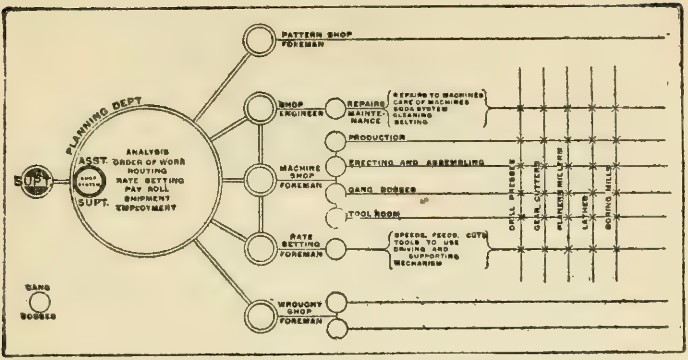
Consulting the proper card in the file, he enters on each time card the time allowed for putting the piece into and removing it from the various machines, time for machining and since the shop is operated on a premium basis, the high and the low rate allowed. The high rate represents a piece-work price for the operation equal to a thirty-five per cent bonus above the man's day rate; the low rate is about eighty per cent of the high rate.

If he does the job in the time allowed he gets the high rate; if not, he is given the low rate. For work on

which there are no instruction cards a special slide rule is used. From this slide rule the rate-clerk obtains the speeds and feeds best suited for the class of metal to be worked. Having taken both the rough and the finished dimensions, he applies the slide rule speeds and feeds, quickly computes the time required for the operation and enters it on the time card. The time cards thus filled out are forwarded to the order-of-work clerk. It is his duty to determine the order of placing all jobs at the various machines; he must work in conjunction with the production clerk.

To expedite the order of planning and to show clearly every stage of the work laid out for a machine, a large bulletin board is used in the planning department. Under each machine number are posted the jobs to be done by that machine: work at the machine and *planned*, in one group; work at the machine but *not planned*, in another; a third showing work *ahead of but not yet ready* for that machine. Each machine also has a small bulletin board immediately beside it on which is a duplicate list of all jobs planned for that machine. From this the gang boss for each group of machines must make preparations for a job at least an hour in advance, procuring drawings, instruction cards, tools, gauges, and so on. This keeps the work continually overlapping and insures the machinist against loss of time between finishing one job and starting another.

These are the essential features of a planning department in an iron working establishment. While it would be expedient to change details to fit given conditions in other classes of manufacturing, it can readily be seen what advantages—both to employer and employee—must follow the application of the principles.



To relieve foremen of all detail this planning department organization is in authority at the Link Belt Company's plant. Each line of work in the department is indicated by the circles. Those machines with which each department has to do are indicated by vertical lines

The planning department is but one example of foresight in getting out work. The whole shop is run on this same scientific class. Work is done by a plan. In a smaller shop a less elaborate system is more practical but the idea of standardizing methods and operations is applicable in any factory.

An unusual example of the value of planning work ahead in this manner was recently found in a tailor's supply factory where the style of the commodity manufactured changed radically from season to season.

The goods are made to stock in a semi-finished state. Goods to be finished are ordered from the semi-finished stores on requisition from the planning department which keeps track of sales and manufacturing conditions.

In other words, the planning department in this concern does not lay out the detail work of manufacture, but acts as a balance wheel preventing overstocks and the necessity of handling job lots of displaced material. It is more than a production department; it is less than the sales department.

CHAPTER VII

Laying Out Work for Each Man

ALTHOUGH scientific principles of management were first applied to the operation of machine shops by Fred W. Taylor, the principles are universal —they can be applied even to millinery shops with equally astonishing results, and they have been successfully applied to a wide range of industrial activity.

The writer applied them to a woodworking shop—a boat shop, to be specific—and the results are already extremely gratifying.

A plan for doing work is the basis for the methods now applied in this factory. The detailed methods of processing work cannot be put in force without preparation. The "departmentalization" must be carefully studied out, so as to get clear lines of demarcation and distribution of work to proper classes of labor. Then the shop arrangement must be fitted to these departments; distribution of space, arrangement of tools, and so on. This problem has to be specially solved for every shop; no two are exactly alike.

Then the equipment of the shop—machine tools, their appliances and attachments and hand tools—must be brought up to first-class condition. One cannot expect

a mechanic to do good work with inferior facilities, *and do it economically.*

In this boat shop navy boats, all built to standard plans and specifications, the same for all navy yards, are constructed. But these boats are also repaired, so that the problem was that of a combination manufacturing and repairing shop, presenting more difficulties than the simpler problem of the purely manufacturing concern.

The shop is large, affording ample erecting room; a space was cleared for the handling of raw stock, and a lumber rack provided. The general layout insures as far as possible that the stock in process shall not double on its trail.

The tool equipment was good, in number and quality; but a few slight changes in arrangement, and the provision of a few attachments and appliances, yielded surprising benefits. A compressed air system for operating air drills and boring machines is one of the shop's best assets.

The stock of standard patterns, molds, and jigs was carefully stowed and indexed; hand tool equipment gone over; the shop stock of material inventoried and renovated. Finally, the shop was given a thorough cleaning.

When these main changes were completed, the detail plan had to be made and applied.

It is absolutely necessary to tell the mechanic exactly what you want him to do. The question is, into how much detail shall we go? There is one best way to do a job, and that is the way the house wants it done. If the job is to be carefully thought out, and the best way settled on, who is the best man to do this thinking?

The mechanic on the job is the man least qualified, because if he is of the average, or below it, the chances

are that he won't get the best way. And if he be above the average and hits on the best way, he loses time—which means that the production per dollar of investment suffers. The more definite and detailed the instructions the better; and the foreman, or, in a large shop, an assistant, is the man to get out these detailed instructions.

The instructions prepared, who will do the work? How will it be kept moving through the shop? How make sure it is not forgotten, or that more important jobs are not side-tracked in its favor? The foreman has to plan this out, in advance. And who has to supervise the workmen, and coordinate their work? The foreman.

Is not the foreman entitled to mechanical aid in the performance of his duties, quite as much as is the lower paid mechanic or operative?

These questions were answered in our shop by applying Mr. Taylor's principles of planning work. A planning board like that at the Link Belt Factory is used in this boat shop. Filing drawers are provided both for active and dormant orders. The board above the shelf carries pairs of hooks, and a pair is assigned to each workman. The board is "departmentalized" in the same way as the shop: the supervisory and non-productive force; the material department providing and laying out all stock; the milling department doing all machine work; and the erecting department assembling the parts into the completed boat.

Little cards, called standing orders, are provided, and one is hung on each man's hooks for each job assigned him, the top card being the one on which he is at the time employed. It is plain that this board is a miniature shop, and that work may be planned on it, the jobs being assigned to the suitable men or machines and the

sequence carefully thought out. And this planning once done, need not be done again unless a change is necessary. The planner can't forget it.

For each constituent operation of an order an instructions card corresponding to the standing order is written at the time the work is planned, and, when issued to the workman, it is hung in plain sight in a tin rack at the workman's bench. To insure definitely the complete occupation of the employee's time three jobs are assigned him; he is working on one, the second is ready—all materials and appliances at hand, and the third is either ready or the stock is in the material or the milling department. When a job is completed, the mechanic hangs his card on a hook on the lower right hand corner, moves up the other two, and goes on with his work. He doesn't have to work on one job until the foreman gives him another, and he gets detailed instructions covering the job he is on. The rack always shows the foreman what the man is doing, and calls attention to the jobs ahead, so that it is of the very greatest value in coordinating the work of the various departments.

The more minute the subdivision of the job into its constituent operations, and the more definite and specific the instructions as to each operation, the less thinking and the more work on the part of the man.

With these instructions cards, bearing the order number, accuracy in charging is promoted; and the cards, used as records of cost, form the best means of judging the comparative excellence of the men—their value to the house.

In the old way, the mechanic was given a job to carry through. He took his own time and did it his own way. But when work is processed, and the proper class of labor for each operation employed, it is necessary that

each man know how far he is to go; and it is also necessary that each man get through with his job in time for the next man to take it up, for that next man isn't going to be caught loafing if he values his job. And the work must be done right, or the next man will kick, lest the boss find him with a piece of imperfect work. The whole thing becomes an interlocking and smoothly working mechanism if correctly planned and supervised; and the most trouble occurs under the conditions producing apparently the smoothest running under the old system.

As I have said before, the principles, not their manifestation, can be applied; I describe this particular organization as an illustration of some of the principles involved. I devised and applied an organization, based on the same ideas, to a sheet-metal shop under my immediate supervision, and within a week a lay-off was necessary. The work of the shop is held up to the light; nursing jobs becomes a lost art.

The present stage of development of this boat shop is very satisfactory. One kind of boat, for example, that used to cost $780.00, we now produce at $631.00, and as we go along we improve. Any shop organizer who promises "results" in a few months is an optimist, to use a euphemistic term. You get *rapid development in months, results* in the course of a *year* or more.

The immediate benefits of this organization are improved arrangement and ample and efficient equipment. The foreman is enabled to plan his work well in advance, to get detailed instructions to the workmen, to coordinate the work intelligently, and with much more time left for actual supervision. Production has been increased; costs decreased, and better work done.

CHAPTER VIII

How Men Are Trained To Industry

SINCE the raising of efficiency is the first purpose and final end of scientific management, it follows that the training of workers is the pivotal task—the hinge on which the whole plan swings forward to success or lags backward to defeat. It profits you nothing to discover or develop the one best way of doing anything and everything in your factory or office unless you can teach this right way to the men who put your materials through your machines. And because this standard method is always a departure from the customary one, and frequently forms a difficult task, this training must be training in the fullest sense of the work—teaching, demonstration, practice, correction of flaws and encouragement.

Neither the general instruction and practical work which prepare apprentices in the ordinary shop or the "breaking in" of a new mechanic or one assigned to an unfamiliar job will serve here. Instead, is required the patient, individual instruction and drill of every man in the organization until he *learns* the one best way of doing his task—until he so *masters* this right method that he can finish in the time allotted for the task—and until obedience to directions and mastery of

the standard method has become a *habit,* both for mind and for muscles.

Preceding chapters have shown how, by time- and motion-study, plus experiment, this "standard" for each process was worked out and adopted—the machine to be used, the tool, the way to set it, the speed, the depth of cut, the sequence of operations, the time allowed for each, the worker's compensation.

Preceding chapters have dealt with the organization which gathered this information, reduced it to standard, applied it to factory orders and thus passed it back to the man. In addition to laying out the right way for each operation and helping the workman to follow it, this planning department and the gang bosses, speed boss, repair boss and inspector in the shop together provide every material element and condition necessary to perform the operation in the minimum time and according to standard.

There remains one other factor in production — the workman himself. All the efforts of the planning department and functional bosses center on making it possible and easy for him to perform a given operation, by a prescribed method, in an allotted time. This demands closer application, quicker thinking, more unflagging industry than he is used to; he must be "on the job" a much greater proportion of the time. Its plain purpose is greatly to increase output; even to double, treble or quadruple what before passed as a day's work.

The workman usually sees very quickly the apparent objections from his viewpoint. If he is a piece-worker he sees his rate lowered even though his earnings increase. If he is a day-worker he is apt to resent the task idea as an invasion of his right to set his own pace or as a new and subtle way of "driving." His class

DEPARTMENT	INSTRUCTION CARD	ORDER NUMBER
D M H		K 1022

DESCRIPTION OF OPERATION TURN, BORE And FACE

KIND OF MATERIAL	CAST IRON	CAST STEEL	FORGING	SHAFTING	BRASS	PHOS. BRONZE	BABBIT	CLASS NO.

GET FROM TOOL ROOM

SKETCH

Preparation
Time Limit-----0.15
Prem. Time-----0.20
Time Basis-----0.25

	DETAILED INSTRUCTIONS	SHAPE OF TOOL	CUTS NO.	CUTS DPH	FEED AMT.	FEED SYMBOL	SPEED R.P.M.	SPEED SYMBOL	TIME WORK SH'LD TAKE
1	Rough Turn O D	PRBB	2		".0527	E	7.33	3A	0.428
2	Fin.	PSFA	1		.184	N	5.37	2A	0.082
3	Rough Bore	Dble EdCtr	2		.0339	D	46.7	3C	0.108
4	Fin.		1		.123	G			0.015
5	Face Hub	PRBB	2		.0301	B	25.1	1C	0.100
6	Rough Turn ODof Hub		2		.0527	E			0.040
7	Sq. Corner				".006	HAND			0.041
8	Fin. Turn OD of Hub	PSFA	1		".184	H	13.8	2B	0.010
9	Set & Rem. Tools								0.264
10	Work on Mach. & Rem.								0.202
11									
12									
13									
14	TOTAL MIN TIME IN HOURS								1.282
15	MACH. TIME (POWER FEED)	0.775-10%							0.077
16	MACH. TIME (HAND FEED)	0.041-25%							0.010
17	HANDLING TIME	0.466-35%							0.163
18	TIME LIMIT								1.532
19	PREMIUM TIME								2.00
20	TIME BASIS								2.46

WHEN MACHINE CANNOT BE RUN AS ORDERED MACHINE BOSS MUST AT ONCE REPORT TO MAN WHO SIGNED THIS SLIP	MONTH	DAY		SIGNED
	4	9	1909	Elrane

NAME OF PIECE	PATT. NO.	LAG. NO.	DWG. NO.	WGT.	O. D.	FACE	BORE	T. W. C. F.	MACH. NO.	CARD NO.
ROLL SPIDERS	C15127		C07677		25 3/8"	4 1/2"	4 7/16"		5-7.8 BV	20207

Instruction card issued by the planning department on standard operations, instructing the workman in all details of the process. Note the plain statements as to the standard time and the rate, and the specific instructions as to tools, cuts, feeds and speeds to be used

psychology suggests, too, that multiplied efficiency means loss of employment to other men in his trade, perhaps eventually to himself.

It is an undertaking requiring patience, tact and understanding of human nature, therefore, to bring the methods of scientific management into a business. The men cannot be dealt with as a mass. It is necessary to deal with individuals until perhaps a quarter of the force has been trained to the new standards, has accepted them and acquired the habit of accomplishing them. Wholesale changes are out of the question. There are mental attitudes as well as hands and muscles predisposed to other methods to be dealt with. The mental attitudes are the harder to modify. Object lessons are needed to change them—object lessons showing individuals accomplishing more and earning more.

In a Cincinnati machinery works, for instance, the first instruction card sent out induced a rebellion of one. The mechanic put on his coat and walked out. He had made no objection to the time-study on which the standards set down on the card were partly based. But the full directions outlined to his mind, an impossible task. The sequence of operations was different from that he usually followed. The time allowed was too brief. Despite urging, he quit.

The second assignment was even more unfortunate. The workman was willing, but incapable of carrying out the instruction (as indeed, a goodly proportion of every working force proves). He made several attempts to achieve the standards; an instructor labored with him for days, analyzing his motions, checking his unit times, demonstrating the right way again and again. Without result, however; the man could not finish the task in the time prescribed.

Meanwhile another mechanic had been hired in the quitter's place. His mental attitude was different; he wanted to hold his job. When the instructor turned to him, therfore, and asked him to try his task, he responded immediately. He failed at every trial for two weeks or more, but the instructor was always at his elbow, encouraging him, pointing out his faulty motions, holding him inflexibly to the standard way. Then, as his old methods were unlearned and practice gave him skill, confidence and speed, he gradually drew up to the standard and accomplished the task at every attempt.

On the older employees in the shop his success had a marked effect. They saw an outsider, a newcomer of no exceptional skill, earning more money than the shop veterans. One by one, the most competent signified their willingness to try the new methods. And as these skilled individuals have all, in the main, "made good" and are earning increased pay, the temper of the force has changed. At present the men are urging greater speed in extending the system than the management cares to attempt.

For it is a cardinal principle in such a reorganization to "make haste slowly." When the training of workmen begins the need of caution and care becomes urgent. The task, the time and the rate can be proved reasonably only by achievement. Not once or twice, but so often that failure becomes the exception and the workman acquires the habit of succeeding, of working at the top pitch of efficiency. His incentive, of course, is the increased compensation—the bonus or differential high rate—which is lost whenever he fails to finish the task in the allotted time or when his product does not pass inspection. This matter of compensation is so important it must be reserved for another article, in

which the various plans will be analyzed and compared.

It is the teaching of the instructor, however, his patient demonstration of the one right way, his insistence on the proper sequence of operations, his repeated analysis of times and motions until the weak spots in the man's performance are found and corrected that shapes the latter's ability and willingness into power to achieve the task. Very few mechanics are capable, at first, of finishing even the simplest operation in its standard time. They have a handicap of mental and muscular habits to overcome as well as new habits to acquire.

Without the constant help and oversight of an instructor, not one in ten would be able to "make good" on the initial tasks. But with continued teaching and encouragement—the essentials of training—industry and obedience to instruction become habits. They develop ability to "make good" on any ordinary operation without other help or supervision than that supplied by the gang boss, speed boss and other functional foremen.

In the first stages of a shop reorganization, one efficiency expert may exercise all the functions of the planning department and these functional foremen. As in the machinery plant already mentioned, one expert makes the time and motion-studies for a group of related operations, fixes the standard time and rate for each, makes out instruction cards for certain factory orders which he has analyzed, and then teaches one or more selected workmen how to carry out these instructions in the standard time. The advantage of this concentration of functions in one boss is that in the time-study and standardization of any operation, the workman gets an understanding of the purpose behind and

Plate X: Even the selection of the tools, determining the gauge, the right packing are all noted on the instruction card given the workman

XI: The workman at the top puts the tool and the packing in place on the machine then tightens the tool and thus makes the machine ready for use. Each movement de according to directions that were evolved as a result of time-study experiments

considerable instruction and practice in the methods to which he must be trained.

To get results this workman must cooperate, or, at least, not obstruct the investigation. If he is handled with the proper mixture of frankness, tact and consideration, his training has already advanced before his first instruction card comes along. Some efficiency engineers, indeed, choose their early subjects for time study as much for their general *intelligence* and open-mindedness as for their skill. From these first subjects, as often as not, the time-study men, rate setters and other functional bosses are developed.

Even when their natural equipment compels them to remain in the ranks, their mastery of one process or group of processes gives them a confidence, a quickness of mind and hand which, when tackling a new task, are good substitutes for journeyman skill. Their training and experience have inculcated faith in the planning department and the functional bosses in the shop. Having proved one set of standards right and profited in the proving, they are ready to follow the instructions card on the new job and ask the help of the instructor or gang boss if they fail to earn the standard time bonus.

This ability to develop high-grade, high-speed workers quickly has special value for an industry subject to contraction and expansion. When the boom comes and experienced men are not available green men can be taught to turn out acceptable work in a surprisingly brief time. With a trained instructor at hand and a minute analysis of each process set forth clearly in black and white, the recruit "gets in hang of the job" much more quickly than when laboring under the haphazard guidance of another mechanic or handy man.

The latter may have unusual personal skill or a method which gives uncommon results, and yet be unable to analyze his method for the new man or put it clearly before him.

When time-study on the other hand, has analyzed this expert way and reduced it to writing and figures, the mechanics or "handy men" very often can be trained to do admirable work as instructors. In textile mills, for instance, and in factories where "repeat" operations are the rule in many departments, the best results are obtained by putting groups of workers under such instructors, who unite all the ordinary functions of gang boss, speed boss and inspector. These instructors, because the field of their activity is limited and is bounded by their previous experience, are able speedily to master every factor bearing on efficiency and pass this knowledge along to the men.

Their pay is based on what their men do; if all accomplish the task and earn the bonus or high rate, the instructors also receive a bonus. In some cases, the reward of the instructor is based on a standard of group efficiency a little lower than maximum individual efficiency. The effect in all cases is the same; the instructor or gang boss becomes not merely a *leader,* the man who tells how the thing should be done and forces compliance, but also a helper and encourager of his men, since the failure of any one of them means his failure also.

The training of workmen may begin after only a few groups of processes have been time-studied and standardized, later including the condition and supply of equipment, tools and materials, as well as actual methods. This in the past has been the normal development. One or two experts, or, in a large plant, several special-

ists from outside, start the work of time-study, of standardization of methods, stores, equipment, speeds and feeds, shop service and transportation. There are at least five separate and distinct lines along which inquiry and the organization can be pushed in the works, office, storehouse and in shops. For one or two men to undertake all the work means slower progress; since operations must be the units of investigation and in turn of instruction. After standards have been worked out for a number of processes, individual men and machines are brought into the program.

Effort must be concentrated, at this stage, on teaching these individuals to perform the standardized operations, without straining or exhaustion, in the minimum time. Their success establishes the reasonableness of the new order of things and the fairness and advantages of the new tasks and methods. Their increased wages the high rate or bonus paid for completion of the task in the specified time adds from twenty to eighty per cent to the man's ordinary day rate, though greatly reducing the unit cost of manufacture furnishes the object lesson, the convincing argument needed to bring others into line and change their antagonistic attitude into one of cooperation.

Yet the finding and training of time-study men, rate setters, instructors or gang bosses, and these functional foremen, is never lost sight of. Competent men in these lines are not numerous. The wisest and, up to the present, the most effective way has been to develop them from within the organization. This developing must be done by or under the immediate direction of a specialist in scientific management.

Too great stress cannot be laid on the necessity of expert counsel based on experience and certified by suc-

cess. Such counsel is the cheapest thing a business can buy. Yet the "efficiency" attitude towards *tasks* and problems can profitably be cultivated and various detail methods and systems be adapted to use in almost any office or shop. For the ordinary type of organization to attempt to make itself over without help and direction from outside, however, would be likely to lead to demoralization, unless caution were exercised at every step and the management were willing to wait a year or more for the first tangible results. If a superintendent is convinced of the value and *inevitability* of scientific management, however, and is able to train an assistant to look after all but new, vital problems in the shops, there is no reason for waiting to secure an efficiency engineer before making a beginning, or even carrying the work of standardization, time, study and training past the preliminary stages.

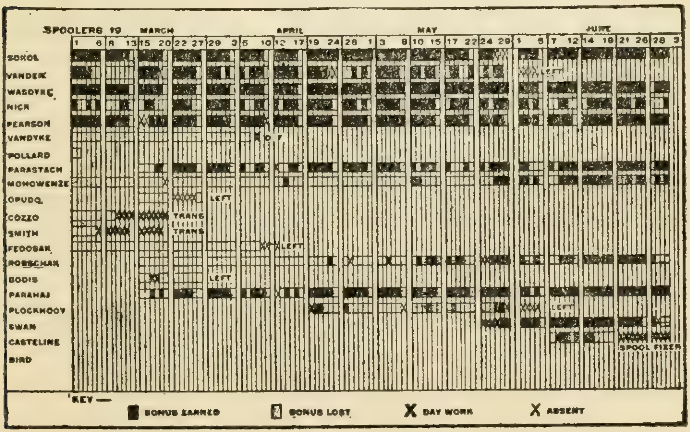
The old organization must be preserved, of course, to carry on production while the "efficiency" staff is bringing the various components (individual workmen and operations first and departments later) into line with the new purpose and program. The most intelligent and open-minded of the old foremen will find their proper places in the planning room or among the gang, speed or repair bosses in the shops. The stubborn and irreconcilable, as the efficiency staff expands, will automatically be eliminated, since their ability consisted chiefly in power to drive.

For their driving has no function under scientific management. Real cooperation is the immediate and ultimate purpose: dragooning or bullying a workman into performance of a task would defeat this end. When his first instruction card is given to a man, if he is a skilled mechanic, he is allowed to carry out the in-

structions himself. Usually the "unit times" specified for the detail operations strike him first: he makes a swift addition and decides that the task cannot be done in the sum of the unit times. He may voice his objections, ask for explanation of the instructions or refuse to carry them out. Since he is sure of his regular day rate, however, he can be persuaded, nine times out of ten, to try the instructions. There the instructor leaves him; to offer help *before discovery* of its need might stir resentment.

Seldom, if ever, does the workman accomplish the task in the time set. Very often he asks, or tries without asking, to perform the task in what seems to him a better or simpler way.

Failure gives the instructor his chance. Stop-watch in plain sight, he follows the operation again and again. If the speed and feed are correct it is easy to prove that the machine is able to do its part. Then by re-



Bonus earnings: This chart records the results of the task and bonus system of paying in a winding room. Note how the workers get the bonus more regularly as time goes on; how usual slumps as on Saturdays, and sometimes Mondays, disappear and how the drones are weeded out

peated trials the detail operations on which the man can also "make good" are tagged and he begins to concede that all the unit times may be right. Having found all the sticking points, training the man to overcome them (if he has the intelligence, skill and energy proper to his trade or grade) is a matter of patient teaching and practice.

The task of course must be feasible and the instructor must be master of it. It is his business to prove that the unit times for the difficult operations are right and to demonstrate to his charge how each can and must be done. The workman may be allowed to hold the watch or the gang foreman may be called to do it. On a process involving many operations, this training may go on for weeks, the instructor giving just as much or little of his time to the job as the nature of the task and the temper of the man demands or allows.

Simply to accomplish it; even to accomplish it three times out of five, is not enough. The training, the correcting and the encouragement continue until the man has acquired both the skill and the habit of doing it every time. In the later stages of this training, the instructor may have several workers under his tutelage and so exercise the functions of a gang-boss. Moving on to another group of pupils, he resigns his first group to the care of a gang boss whose duty it is to hold them up to this standard level of efficiency which they have attained.

This gang boss may be the old foreman, converted to the new methods and schooled in all the operations he will have to oversee. Again, he may be a mechanic or even a common laborer whose latent executive ability has been brought out in the course of his training. For operations are taught as units, remember, and workmen

trained as individuals even when the processes are "repeat" work as in a cotton mill. The class method of instruction is not attempted any more than are sweeping changes involving a whole room or department.

In the foundry of a Chicago machinery works, for instance, the gang boss now in charge of chipping and grinding was advanced to the position within a year after he began work as an absolutely green hand. He was young, energetic and ambitious. Learning the standard method of performing each operation, he accepted it as the best possible way and welcomed the chance to learn the next one. Because of his adaptability he mastered all the department processes in a very short time. In the end, he displaced a gang boss who had never been able to shake off the traditions and prejudices of his rule-of-thumb days.

The experience also of a cotton mill near Paterson, New Jersey, is typical of the mental attitude which must be overcome. One of the most expert of the weavers was chosen to make trial of the standard method. He had been the subject of time-study in preparing this standard, but was unwilling to follow the instructions card or attempt the task set. Accordingly he was passed over and allowed to continue in his customary way. Two others who tried failed for several days to come up to the standard, but the instructor was patient and gradually eliminated the false motions which slowed them up. Then, almost together, the pair "caught the hang" of the right way, and began to earn the bonus for completing the standard task.

Other weavers were put under instruction, the skilled first, the less efficient workers later. Despite the lesson of the first pair, the general attitude was slow to change. The men found the new methods awkward and irksome.

Some of the best producers sought employment elsewhere. But the training went steadily on, was extended as instructors were developed from the ranks and the shop antagonism began to decrease. The man selected for the original trial asked for another chance and succeeded in reaching the bonus basis. Then the rebellious workers began to come back and qualify on task-work.

Finally task-work became the fashion. The least skillful weavers, who had been left for the last, were eager for instruction before their turns came. The new hands reflected the shop attitude, proved docile to instruction and a fair proportion of them were transformed into task workers. Moreover, as the habit of application grew stronger through practice, industry increased. The post-holiday "slump" which had marked Mondays for many years all but disappeared and the irregular workers had fewer and less protracted spasms of idleness. Since the reorganization has been completed, output holds at fifty per cent increase over former figures. Costs are materially lower, though all the men earn higher wages and are the pick of the district in this class of labor.

The weavers were men, foreigners in the main, and unable, many of them, to understand English. How large a part demonstration plays in such instruction is evident: the language of motion is universal.

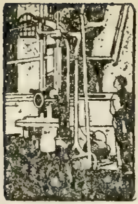
In a textile mill near Philadelphia, employing women, temperament was responsible for many failures in the early months of reorganization. Of the first thirty-six workers put under instruction only fourteen were trained up to the standard. Of the other twenty-two some refused to follow directions, others quit and still others proved incompetent. Coercion was not attempted, however. The capable and willing were trained

to perform the tasks and their example and greater earnings were depended upon to influence the rest. Nor was the result disappointing. In the end, the rebellious offered themselves as pupils; several of them developed into skilled taskworkers.

Experience in this and many other plants has proved that the mental attitude of workers cannot be changed by executive order or by shock. Prejudices must be indulged and the advantages of task-work and fixed standards demonstrated in the only convincing fashion —by appeal to the worker's desire to earn work money through object lessons displayed right alongside him in the shop.

Getting Ready

BEFORE the principles of scientific management can be successfully applied it is necessary in most shops to make important physical changes. All the small details in the shop, which are usually regarded as of little importance and are left to be regulated according to the individual taste of the workman, or at best, of the foreman, must be thoroughly standardized—such details, for instance as the care and tightening of the belts, the exact shape and quality of each cutting tool, the establishment of a complete tool room from which tools are issued under a check system, and, as the foundation of modern management, an accurate study of "unit times." —*F. W. Taylor*



CHAPTER IX

Inducing Men To Increase Output

MORE wages to the average individual is the greatest encourager to industry. After a detailed investigation has been made to increase the efficiency of the factory — after standards of work have been established, based on the scientific study of materials, of machines, of processes, of routine methods of handling work — after men have been trained to follow these standard methods — in short, after the five principles of scientific management, as described in a previous issue, have been applied, there remains one problem — how to induce the men to follow instructions and do the work in the right way. How can the workman be shown that it is to his advantage to keep to standard methods? The answer to this question involves the study of that delicate problem of the relation between employer and employee — the knowledge of what constitutes a full day's work and a fair day's pay.

The management has invested money in investigation and in standardization. He may feel that increased output is due him justly and that the workman receives his benefits in better conditions. But the workman does not look upon his earnings or any portion of his earnings as an interest on investment; he is concerned with this

simple question, "how much will my pay envelope contain at the end of the week?"

So the scientific study of methods of wage payment must take into consideration the relation of the workman to the new plan of carrying on the work. It is at this point where lies the danger of applying scientific principles without definite knowledge of just what principles are involved. *For the method of wage payment in a shop which is scientifically managed is not the important thing, rather it is the attitude of the management towards the wage problem and the method of training the men to meet the new changes which counts for most.*

The average man is naturally lazy. He tends not to increase the pace of work but to decrease it. And this tendency to take it easy is increased if men work together on similar tasks and receive about the same amount of wages. The pace of the group tends to become the pace of the slowest individual rather than the fastest, unless some serum of busyness is injected into the workmen.

This tendency of the workmen to soldier is the first big condition in practical work that started F. W. Taylor thinking about the science of management. And it is the first big obstacle to overcome in applying methods of payment in the factory.

Nor is this attitude on the part of the workmen chargeable entirely to human nature. Workmen have formed habits of laziness because the employer of labor has not known definitely what constitutes a full day's work. Because the man who must meet the pay roll every week has been afraid that he would be "done" if he allowed a man more than an arbitrary wage each day, the workman on his side has formed the habit of doing the smallest amount of work possible and still hold his job. Because neither employer nor employee understand ex-

actly what a day's work is — because they have not faith in the knowledge that there is a minimum amount of time in which each job can be done and that this amount of time has been definitely fixed, have arisen all sorts of misunderstandings between employer and employee. Workmen have banded themselves to increase wages arbitrarily and employers, seeking to increase production and decrease unit cost, have devised half-way measures based not on a scientific study of what actually can be done, but on personal judgment of what is the best way out of a difficulty.

This is not saying that many of the wage payment plans do not work. Depending upon the employer's personality, his ability to gauge work and men — piece work, premium and profit sharing methods of payment have, in individual cases, been successful. But the general failure of piece-work systems, the lack of faith in profit sharing plans, the indefiniteness of what may roughly be termed premium systems, cause all these methods to fall short of accomplishing the greatest good of establishing what Mr. H. L. Gantt has so aptly called habits of industry and cooperation.

Methods of wage payment in general may be roughly classed under day work, piece work, premium system and profit sharing. In spite of the fact that all these plans "work" more or less successfully in individual cases the difficulties that have arisen with day work, with piece work, with premium plans come primarily from a lack of knowledge on the part of the employer and workman of just what constitutes a full day's work and a fair day's pay.

Take the method of paying for work by the piece, for example. By luck coupled with experience and judgment, a piece work rate may be set which is fair to em-

ployer and workman. But often neither know it. On the one hand, if the workmen "stand-for-it" the employer is fearful that he is not getting all he might out of that job; on the other hand, the workman, knowing his employers' fear, may be holding back on the job, fearful that the rate will be cut if he accomplishes all he can.

Examples might be given without number. The fact that ordinary piece work rates are cut and that they fail in accomplishing the greatest good to both parties concerned because of the suspicion this fact causes, have been illustrated again and again.

Here is a young man who secures a job in the brass finishing department in a big works. He is a "green" man and starts in at day rates to learn polishing. Specialized as such work is, he knows enough about the job in three weeks to go on piece work, and in two months he exhibits a pay check in the family circle calling for fourteen dollars.

"It's pretty good, now," he says, "but it's as much as I will get if I work here ten years." "How is that," inquires the father. "You are on piece work and you will surely get more expert as time goes on."

"Sure thing," says the young man, "but fourteen dollars is the limit. If any man runs over that in our room he will get his head punched — and he will get the rates cut, too."

Yet, in this case, the factory in which piece work rates is set by ordinary means with these ordinary results, has to send several hundred pounds of castings each day to an outside shop to be polished because their own equipment is inadequate for the men.

In day work a man is paid by the hour or by the day; in other words, for time put in — not for work turned

out. In piece work he is paid for work turned out. Premium systems have been devised in which a certain amount of work is set as a minimum and any gains in time or money saved over this standard are shared by employer and employee. In some systems half and half; in others, the workman receives an increased percentage as his output increases.

Profit sharing is another plan which some concerns have adopted as a direct incentive to increased output, but under average conditions its benefits are weakened because the reward for increased effort is too far distant.

It is at this point that scientific management departs from methods of management in the average shop. Scientific management leaves nothing to chance. It seeks to establish procedure on the basis of facts. And this basis of facts in the paying of wages in the shops scientifically managed is obtained by unit time studies and detailed analyses of jobs as has been shown in the preceding articles.

All wage payments under scientific management are based on four principles. First, a large daily task for each man in the establishment. This task is not vague or indefinite and is circumscribed carefully and completely. It is not easy to accomplish. Second, standard conditions. Each man's task should call for a full day's work. At the same time the workman should be given such conditions and appliances as will enable him to accomplish his task with certainty. Third, high pay for success. Every man should be sure of large pay when he accomplished a task. Fourth, loss in case of failure. When he fails he should be sure that sooner or later he will be the loser by it.

It will be seen that there is nothing radically new in these principles and that they do not propose any me-

chanical method of handling the question of wage payment.

As a matter of fact, the principles can be applied either under day work, ordinary piece work or premium plans of various sorts and they have been applied under all these conditions. But this is the point: *In no case should an attempt be made to apply these principles unless an accurate and thorough time study has previously been made of every item entering into the day's work.*

There is no one wage system for any group of industries that is best for all conditions; there is no one system of wage payment best even for one factory. In the Bethlehem Steel Works where Mr. F. W. Taylor has put his principles of management into operation, all these methods of wage payment were employed under scientific management, but two methods proved particularly successful in introducing standard methods of work into the factory. One, the differential piece rate system invented by Mr. Taylor; the other, the task and bonus system invented by Mr. H. L. Gantt. Of these two systems, the task and bonus system has proved to be particularly applicable in changing over from former methods to more exact and scientific methods of management in factories.

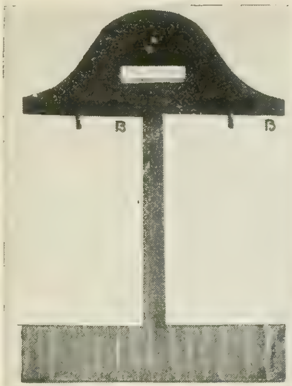
In the differential piece work system work is paid for by the piece. Elaborate time studies, as has been shown, form the basis for making a minimum piece work price. The only difference between the scientific piece work rate and that in the average factory is that the scientific piece work rate is based on *an exact knowledge of the time for detailed operations of doing a job,* — not one man's judgment or two men's judgment of the time it ought to take to do the work, but an analysis of the exact time, taken with a stop watch by a trained investigator

when different workmen work on the same job, under ideal conditions, with the best tools, the best material and the best working arrangements that the manufacturer can supply.

The word "differential" in the Taylor piece system, is made clear in an example from practice. This was the first case where the differential was applied, in the Bethlehem Steel Works in 1884 and was described by Mr. Taylor in a paper before the Mechanical Engineering Society in 1895.

A standard steel forging, many thousands of which are used each year, had for several years been turned at the rate of from four to five per day under the ordinary system of piece work, fifty cents per piece being the price paid for the work. After analyzing the job, and determining the shortest time required to do each of the elementary operations of which it was composed, and then summing up the total, the writer became convinced that it was possible to turn ten pieces a day. To finish the forgings at this rate, however, the machinists were obliged to work at their maximum pace from morning to night, and the lathes were run as fast as the tools would allow, and under a heavy feed. (Ordinary tempered tools one inch by one and one-half inches made of carbon tool steel, were used for this work.)

It will be appreciated that this was a big day's work, both for men and machines, when it is understood that it involved removing, with a single sixteen-inch lathe, having two saddles, an average of more than eight hundred pounds of steel chips in ten hours. In place of the fifty-cent rate, that they had been paid before, they were given thirty-five cents per piece when they turned them at the speed of ten per day, and when they produced less than ten, they received only twenty-five cents per piece.



At each machine at the Mare Island Navy Yard is a rack for time cards for the men's convenience

JOB.NO. 3080 C

OBJECT Stocking 4 20' whaleboats

DATE July 24, 1910

CHECK NO. 2347

NAME John Doe

PAY 2.64

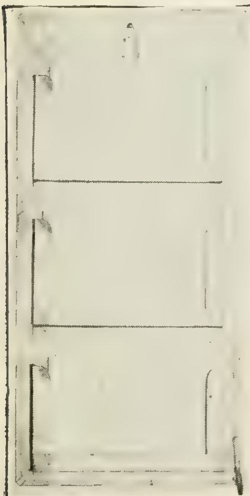
HOURS 8

TOTAL

APPROVED BY –

ENTER BUT ONE JOB ORDER ON EACH CARD

Plate XII: Instruction cards at the Mare Island Navy Yard are made out for two jobs ahead of the one at which the man is engaged. This "job ahead" ticket and the "engaged job" ticket are kept in the metal pockets at the machines



2399 3080. C

7-24 10

Set up moulds & plank 20' W. B.
M 700 Caulk & finish outside & m

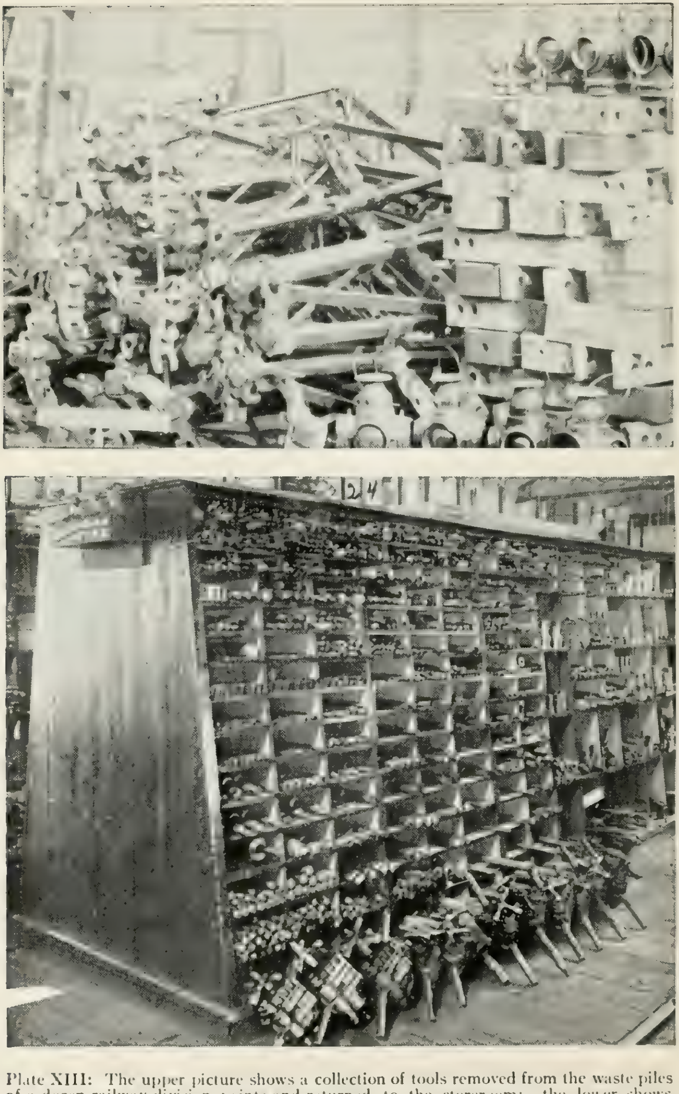


Plate XIII: The upper picture shows a collection of tools removed from the waste piles of a dozen railway division points and returned to the storeroom; the lower shows serviceable material gathered from a scrap heap

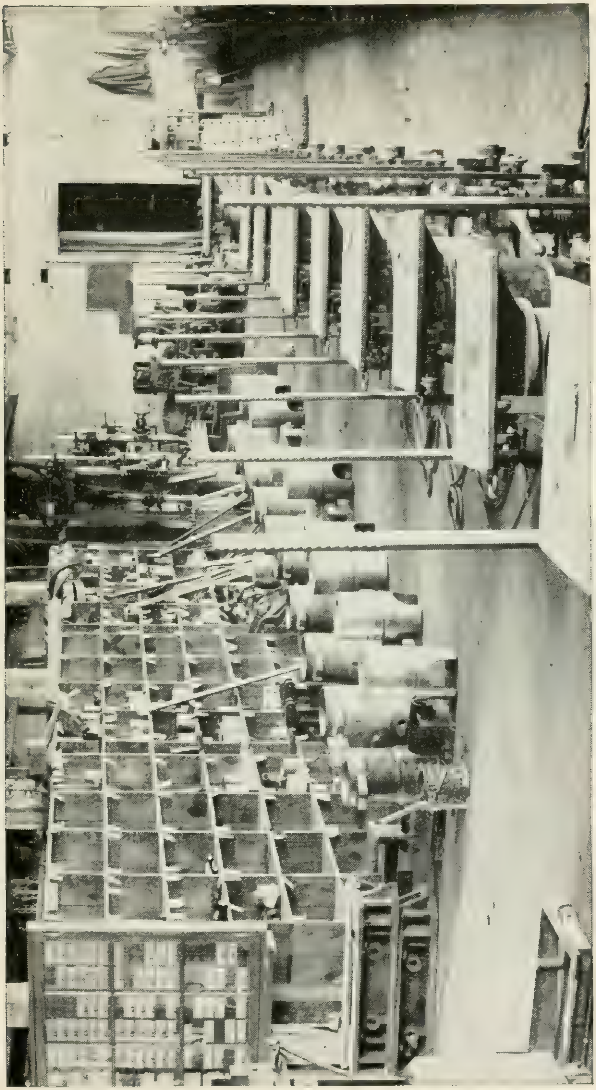


Plate XIV: At the Tabor manufacturing plant all the parts for a given lot of machines in the assembly room are "routed" on a schedule which brings them to the tagged bins at the left on time. At the extreme left is a department or "suitable" planning board for the gang bosses

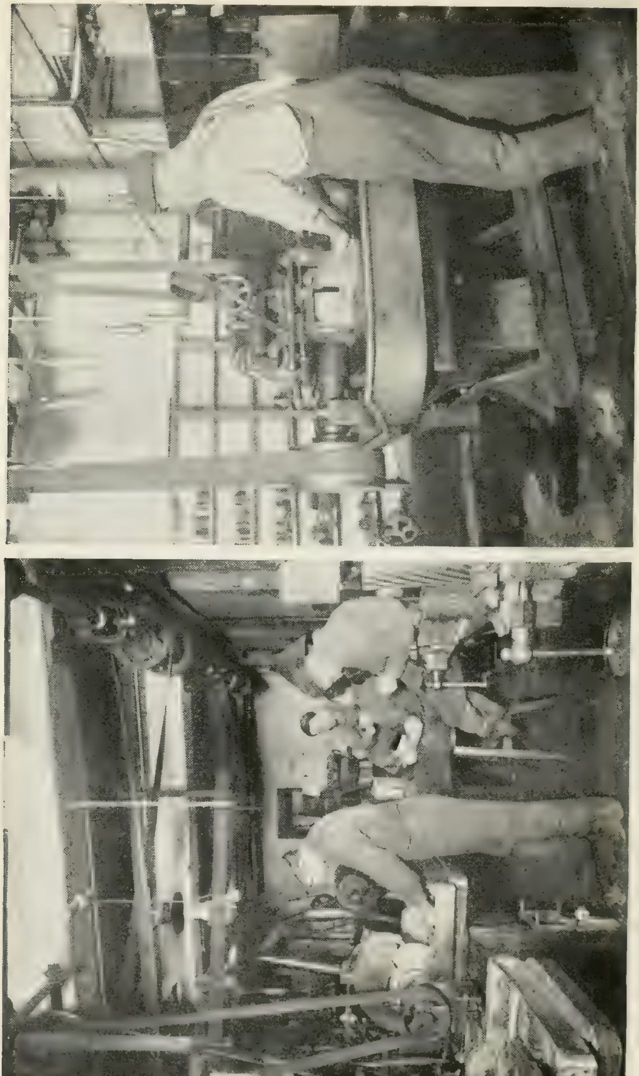


Plate XV: Grinding tools the old way wasted the time of the men and resulted in non uniform tools. The tool grinder and tool-keeper save time and make standardized cutting edges possible

It took considerable trouble to induce the men to turn at this high speed, since they did not at first fully appreciate that it was the intention of the firm to allow them to earn permanently at the rate of $3.50 per day. But from the day they first turned ten pieces to the present time, a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate. Throughout that time until the beginning of the recent fall in the scale of wages throughout the country, the rate was not cut.

During this whole period, the competitors of the company never succeeded in averaging over half of this production per lathe, although they knew and even saw what was being done at Midvale. They however, did not allow their men to earn over from $2.00 to $2.50 per day, and so never even approached the maximum output.

The following table will show the economy of paying high wages under the differential rate in doing the job:

COST OF PRODUCTION PER LATHE PER DAY

ORDINARY SYSTEM OF PIECE-WORK		DIFFERENTIAL RATE SYSTEM	
Men's Wages	$2.50	Men's Wages	$3.50
Machine Cost	3.37	Machine Cost	3.37
Total cost per day .	$5.87	Total cost per day .	$6.87
5 pieces produced		10 pieces produced	
Cost per piece . . .	$1.17	Cost per piece . . .	$ .69

The above result was mostly though not entirely due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable. Too much emphasis cannot be given to the necessity for a detailed study before setting rates; the necessity for sub-dividing each operation into detailed steps as was done on this job. It is in this study of "unit-times" that scientific rate setting differs from the ordinary.

The task and bonus system, the second method of wage payment which has been used successfully under scientific management, like the differential piece work system, is based on a unit time study of the operations on a job. But its value over differential piece work rates comes from the fact that it is educational in character — that it is easy by this method to teach the man how he can make more as the job progresses.

REC'D ISS'D		CHARGE SYMBOL
OPERATIVE'S NAME		OPERATIVE'S NO. D 4
		MACHINE NO.
TIME ALLOWED	TIME TAKEN	OPERATION
BONUS	RATE	CLOCK READING
		FIRST
PAY FOR	WAGES	LAST
IF WORKING ON BONUS CROSS OUT THIS ☞	LABOR	DIFFERENCE
IF WORKING ON LABOR CROSS OUT THIS ☞	BONUS	YARDS
DETAIL OF WORK ON BACK		

ENTERED IN				I HAVE INSPECTED THE WORK REPRESENTED BY THE ABOVE ENTRIES AND BELIEVE THEM BOTH TO BE CORRECT. SIGNED BY FOREMAN________
SCHEDULE	MAN RECORD	PAY SHEET	COST SHEET	
				DEPARTMENT D 4 TIME CARD

This time card is arranged for the payment of bonuses in a textile mill. It meets definite conditions, and illustrates, not a time card system, but one link in a chain of management

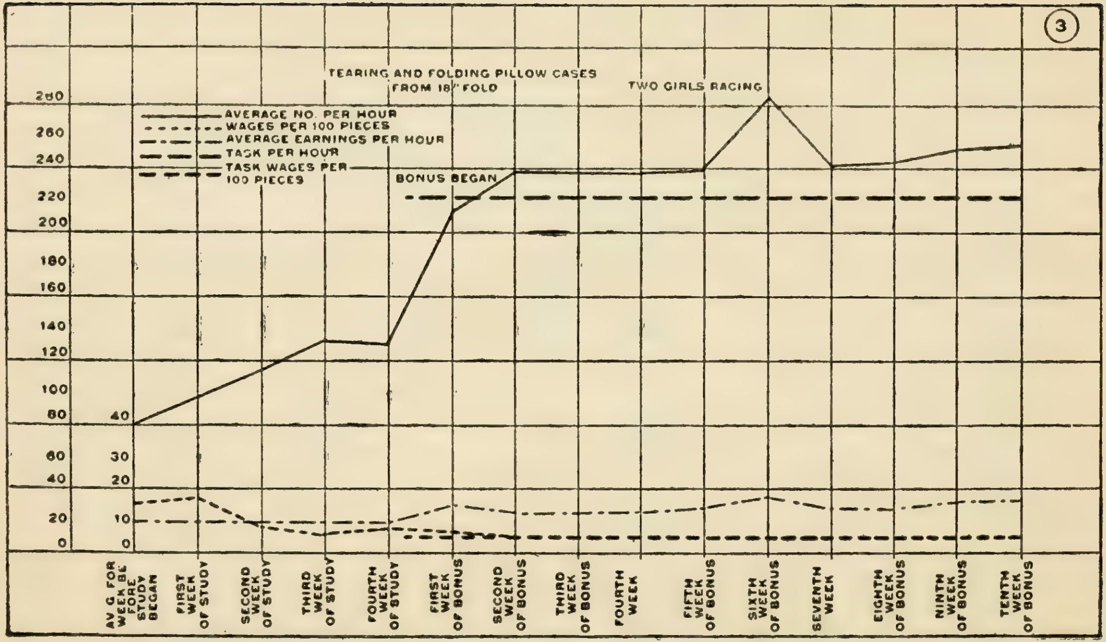
Differential piece work, Mr. Taylor himself says, is best applied where the same work is repeated over and over again. With the task and bonus system, the day's task can be laid out on an instruction card and a definite time assigned to it so that the workman will know exactly what to do and how long a time it should take him

to do it. If he accomplishes the work in the time set he receives a bonus. If he fails of accomplishment he gets merely his day wage. Mr. Gantt interestingly describes his method in a paper which was presented before the American Society of Mechanical Engineers in 1908.

People, as a rule, prefer to work at the speed and in the manner to which they have been accustomed. They are usually willing to work at any reasonable speed and in any reasonable manner if sufficient inducement is offered, and if they are so trained as to be able to earn the reward. In carrying out this plan men are first selected who are already skilled and able to perform the task set. It frequently happens, however, that the number of such men is insufficient and it takes time to train the unskilled to a proper degree of efficiency; but with a bonus as an incentive, and a proper instructor, a very fair proportion of the unskilled finally suceed in performing a task that was at first entirely beyond them.

Unskilled workmen, who under these conditions have become skilled in one kind of work, readily learn another, and soon begin to realize that they can, in a measure make up for their loss in not having learned a trade.

As they become more skilled, they form better habits of work, lose less time and become more reliable. Their health improves, and the improvement in their general appearance is very marked. This improvement in health seems to be due to a more regular and active life, combined with a greater interest in their work. Work which interests us and which holds our attention without any effort on our part, tires us much less than that we have to force ourselves to do. The task with a reward for its accomplishment produces this interest and holds the attention, with the invariable results of more work, better work and better satisfied workers.



This chart shows what bonus payment accomplished in a textile mill. The upper horizontal lines in each figure represent the number per hour that must be finished to get a bonus. The lower lines represent wages per hundred pieces when bonus is earned

An interesting application of the task and bonus is that at a textile factory in the department where sheets and pillow cases are made.

Here was the simple operation of sewing sheets and pillow cases and it was supposed that the work was being done economically. Analyzed scientifically, the results were astonishing.

In order to make any improvements it was necessary to find out in detail: first, what the various operations of making a pillow-case or sheet consisted of, and how these operations were being performed; second, to cut out any unnecessary operations, and to shorten the route travelled by each piece; third, to develop the best way of performing each operation; fourth, to set a proper task for each operation, and to offer a suitable bonus for its performance; fifth, training the girls to perform their tasks properly.

The making and packing of the pillow-cases were subdivided into eleven distinct operations:

1. Tearing the cloth into proper lengths,
2. Sewing up the side,
3. Sewing up the end,
4. Turning inside out (inspecting),
5. Hemming,
6. Sprinkling and (inspecting),
7. Mangling or ironing,
8. (Inspecting) and folding,
9. Ticketing,
10. Ribboning and bundling,
11. Packing.

In the same way the five steps were carried out in detail as analyzed.

To show how the bonus system was applied in this case, take the second and third operation, sewing up the side

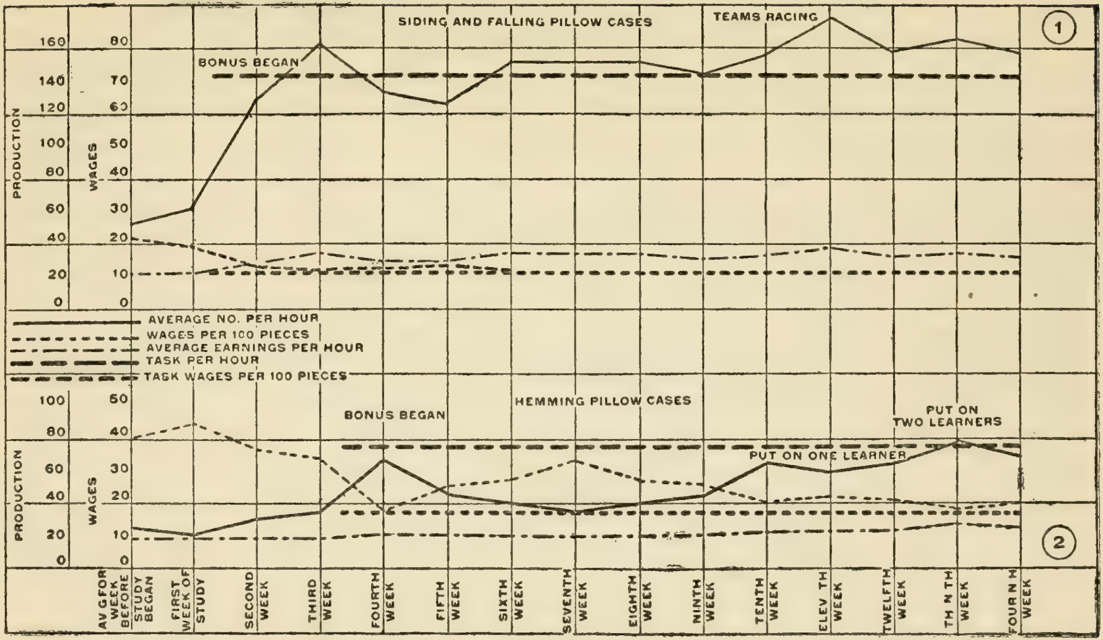
and sewing up the ends. The machines on which these operations were done were placed one ahead of the other, and the work was done tandem. The first girl took the top pillow-case from a pile, sewed up the side, and pushed it on to a slide, which took it to the next girl, who sewed up the end and dropped it into a box beyond her machine. A third girl turned it inside out, inspected it, straightened it, and placed it on a truck.

A careful time and motion study revealed the fact that, whereas the average number of pieces per hour sided and felled by a team of two girls during the week before the study was begun was fifty-three, it was possible, later, to set a task of one hundred and forty-two per hour. The reward for the performance of this task was pay for the time allowed plus twenty per cent of that time. If the task is not accomplished the worker gets simply her day's pay.

With this reward in sight, and with careful training and watching, two teams soon learned to earn their bonus every day. The increase in output per hour, the increase of wages when the bonus was earned, and the reduction of wages per one hundred pieces is shown in the chart.

It will be seen from the specific examples given of piece work and bonus work that the principles laid down are the all important features to consider and that *these principles may be applied to any method of wage payment providing the basis for the payment be made scientifically,* so that a full day's work or a fair day's pay will be guaranteed.

Piece work, as has been said, can best be applied to jobs which repeat themselves over and over again. When there are a number of miscellaneous jobs which have to be done day after day, none of which can occupy the entire time of a man throughout the whole of a day and



Siding and felling pillow cases in a textile mill. The upper lines represent the number per hour that must be earned to get any bonus; the lower horizontal lines represent wages per hundred pieces when bonus is earned

when the time required to do each of these small jobs is likely to vary somewhat each day, the day work system is the most practical method of payment. And here the principles laid down can be applied if the time it takes to do each job is analyzed and enough jobs are grouped into a daily task which can be assigned to one man, possibly even to two or three.

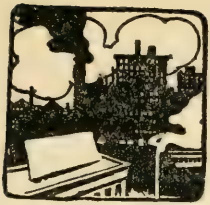
For example, in a small boiler house in which there is no storage room for coal the work of wheeling the coal to the fireman, of wheeling out the ashes, helping clean fires and keeping the boiler room and the outside of the boilers clean could be made into a daily task for one man. If these items in a factory do not sum up to a full day's work, other duties may be added.

In a small factory which turns out a uniform product in uniform quantities day after day, task work can be laid out in a similar manner, and an incentive given to accomplish this day's work for more than a usual day's work for that sort of a job so that the position will be sought for by first class, ambitious men.

Task work has the advantage in that each man works as an individual. His task is laid out for him and there is not the desire on the part of the workmen to bring influence and pressure to bear and so cause the best man to slow down toward the lower level as is the case on plain piece work.

ESTABLISHING a planning department merely concentrates the planning and much other brain work in a few men especially fitted for their task and trained in their special lines.

—*F. W. Taylor*



CHAPTER X

Paying Higher Wages To Cut Costs

YOU would think twice before spending 28.4% more for wages on a job. Yet if you can increase production 89.6% and reduce costs 32.7%, the facts are seen from a new angle.

For in a nutshell that is the result of applying scientific method of studying some special jobs in an eastern textile machinery house.

Higher wages mean reduced costs only when production is increased more than enough to cover the increased cost. As a rule, every workman is waiting for an opportunity to enlarge his income, and will almost invariably do more work for an increase in pay. Not only will he do more work under the efficiency plan but he will do it better and easier than when he was left to teach himself.

The manufacturer is interested mostly in actual results and the question which he is asking is this: Will it pay to make a careful study of my factory methods, with scientific principles as the test. In many cases it has surely been a great benefit, and in this particular factory where braiding and cabling machinery is made, some interesting and helpful results have been obtained. The management hired a technical graduate to intro-

duce the principles of scientific management and a piece payment system, the results have been satisfactory to both employer and employee.

The first step taken in preparing for increased production was the introduction of simple card systems and tickets to show material in stock, material ordered and received, and cost of work in progress up to the time of completion.

The second was the study of individual parts and operations preparatory to setting rates. In this the following plan was carried out:

1. Finding the best tools, speeds and feeds.

2. Making improvements on appliances and jigs.

3. Saving time and effort of the workman by bringing material to be used close at hand.

4. Showing the operator, when necessary, how to save time by making fewer well directed motions easily and quickly.

5. Timing efficient operations of the best workman available.

6. Having the workman time the writer on some classes of work so that the operator would know better what could be done.

7. Gaining the confidence of the workmen by being one of them and friendly with all.

8. Showing the men that you intend to master every difficulty and to find a way to get out better work faster.

9. Making it clear that the new system to be put in is for their benefit as well as the employer's and will be equally fair to both.

10. Determining the day's work and setting the rates.

At the start the classification of jobs into piece, day and premium work is an important point. Most of the

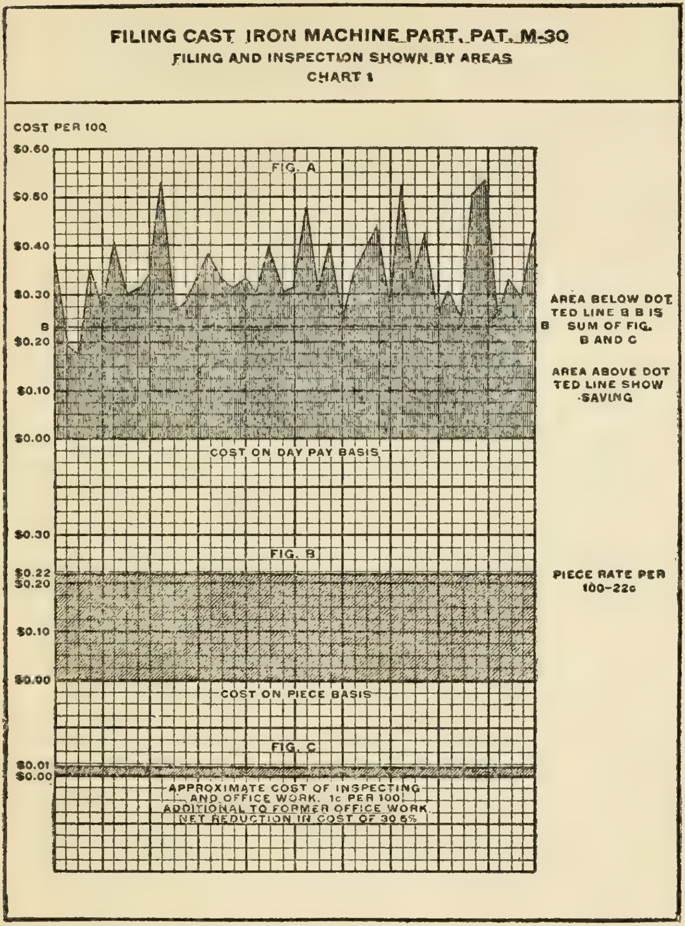


Chart I: Figure A has been plotted from the relative costs of machining the same kind of casting at nearly forty different times. The area in Figure B represents the costs after a scientific study had been made of the work and men and every man trained to his highest efficiency; the area in Figure C is an approximation of inspection and office costs; and the area above the dotted line BB represents the saving in costs accomplished by the change of methods and establishment of a better system of rewarding men for piece work

work as carried through this factory seemed suitable for piece rates at fixed prices per one hundred pieces. Sufficient allowances were made so that the workman could, by following the directions of the investigator, earn in time, a bonus above his old day wage.

Other classes of work seemed suitable for premium rates. The workman was guaranteed his day pay and extra compensation equal to half the time saved over and above the allowed time.

In other departments where it was difficult to determine exactly what should be the day's work, the following plan worked out equally as well as piece or premium rates:

Suppose that the assembling man puts up six machines in ten hours under the day wage plan and that the investigator determines by the above methods that eight machines can be assembled.

If the day wage is \$2.40, six machines would cost forty cents each. Now we said to the workman that for every machine he could put up over the six, we would divide with him on the amount saved.

Then if he completed seven machines, his pay would be \$2.60, if eight machines, \$2.80, if nine machines, \$3.00. But eight machines is the day's work and by following instructions the workman can, in time, complete this amount per day.

If castings come poor or delays occur and he falls below the standard, he still makes a bonus in proportion to his effort and efficiency. If he does but five machines, which rarely ever happens, he must lose the premium of twenty cents and receive but \$2.20.

In this way production is increased from six to eight machines, or 33 1/3 per cent, wages have increased from \$2.40 to \$2.80, or 16 2/3 per cent, and labor costs have

been reduced from 40 cents to 35 cents each, or $12\frac{1}{2}$ per cent.

The foreman is an important man in establishing efficiency methods. In order to make the new scheme look attractive to the foreman and to overcome, if possible, the prejudice which they might have toward the changes, it was decided that each should receive weekly a certain percentage of the total bonus or premium earned by the workmen in his department. This plan proved entirely satisfactory from the outset and enlisted the aid and approval of those whose help often proves more difficult to obtain than that of the workman himself.

With the introduction of piece rates there is apt to be a falling off in the quality of the output. This, of course, must be avoided by a thorough inspection of each day's work before the workman receives credit for amount completed.

RECORD OF OPERATOR NO. NAME DEPT.

DATE	PART	PAT NO.	OPERATION NO.	QUANTITY	PIECE RATE	PIECE COST	HOUR RATE	HOURS	HOUR COST	P. & D. COST	DAY COST	BONUS

In order to have the bonus system work out satisfactorily among a number of men, there is necessary a good card record like the above, to accurately check what each man really does

Once the rates are set and the changes are starting in, it is very desirable that a daily record of each opertor should be kept. Such a record would show the progress of each individual and varying hour costs of each piece as the work went on.

If made up in some such way as shown on the printed form below, a single glance would tell the story. A manager or superintendent with a daily record at his command would control the whole situation.

To illustrate in a general way how costs may vary when work is done by the day wage system, Chart I should be studied. The Figure A on Chart I has been drawn up to cover some forty different orders on one class of machined parts. This was all hand filing by three workmen receiving two different rates per hour for the same work.

After the costs on this part had been studied scientifically the piece work costs of these jobs may be represented by Figure B, Chart I. The reduced area shows the amount paid for the same work done efficiently. The approximate costs for inspection and additional clerical work is illustrated by Figure C, Chart I. The saving is the amount represented by the area above the dotted line in A, Chart I.

How costs, production and wages vary under the old and the new methods is shown in Chart II. Costs are reduced 32.7 per cent, wages increased 28.4 per cent. Production is increased 89.6 per cent, which means that, with the same amount of business under both methods, a little more than one-half the help would be required under the efficient system.

The weekly bonus earned above old day wages is illustrated in Chart III. It is the result of four months of piece work by the workmen in one department en-

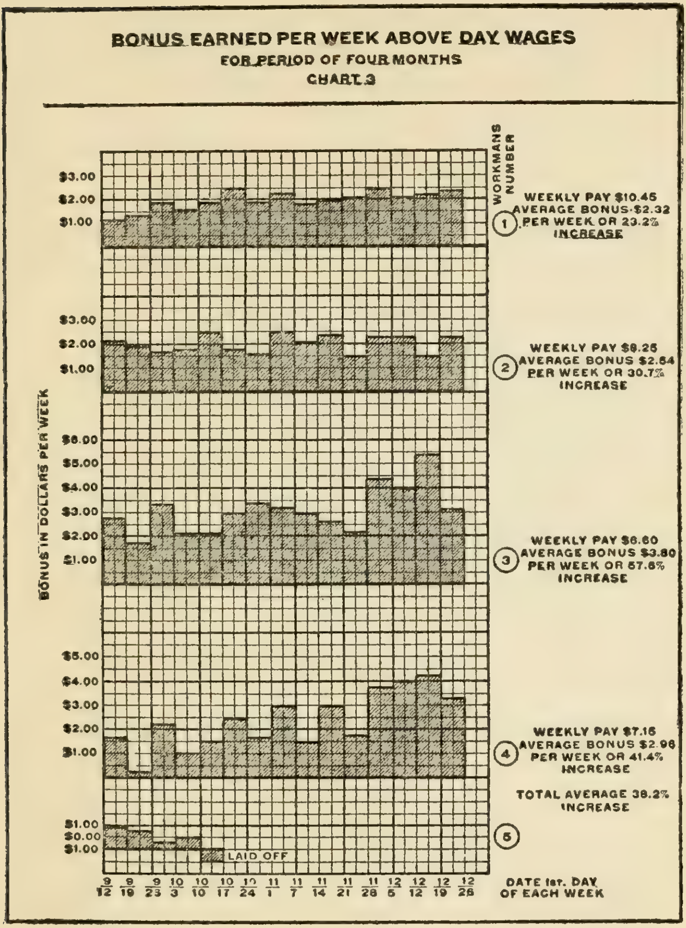


Chart III: These five carefully plotted areas are an accurate check on the abilities of five different workmen during a period of sixteen weeks. In the first case the workman attains a maximum bonus and works steadily, with small variation from week to week. The second man is not as steady in his work. The third man at times accomplishes double the results of his team mates but works spasmodically. In the last case, the record is sufficient evidence to discharge a worthless mechanic

gaged on the seven operations shown on Chart II. Note the increases of pay of four workmen from 23.2 per cent to 57.6 per cent and the cutting short of the career of the poorest workman, No. 5.

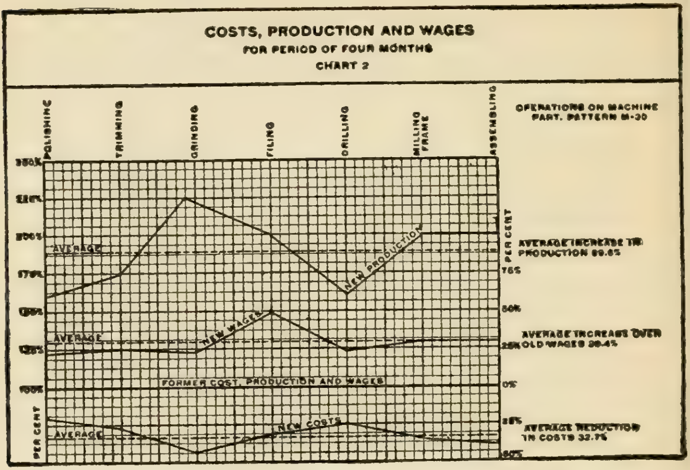


Chart II: Curves which show the changes in cost, production and wages when scientific management was adopted. This is an accurate method of comparing results in each department. Production increases 89.6%, and costs are reduced 32.7%, although the line indicating increase in wages goes up only 28.4%

The efficiency methods as outlined above can be applied in different ways to many classes of work but they appeal especially to the manufacturer. They do not call for radical changes in every case, but they do require time for the changing of old customs and habits.

To introduce a plan of this sort requires special training and experience but most of all it calls for confidence in the investigator by the management and the firm support of new methods when once they are begun.

These new methods are for the purpose of reducing costs and when accomplished may often mean the difference between failure and success.

How scientific management is applied

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